

A PILOT STUDY FOR THE APPLICATION OF WORLD CLASS
MANUFACTURING TECHNIQUES IN THE FIBRE-CEMENT INDUSTRY.

BY

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I, E.J.W. Aggenbach, submit this thesis for the degree of
Master of Industrial Engineering. I claim that this is my
original work and that it has not been submitted in this or
any similar form at any University.

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SUMMARY

World Class Manufacturing(WCM) is a set of management strategies developed in Japan. These strategies have helped Japan to become the world leaders in manufacturing. This is obvious when the quality, price, availability and range of Japanese products are compared to those produced elsewhere.

This thesis consists of two sections, namely, a literature survey discussing the various components of WCM, and a description of an application of some of these techniques.

WCM consists of four separate building blocks, namely, Just-In-Time(JIT), Total Quality Control(TQC), Total Worker Involvement and Total Productive Maintenance. These building blocks are discussed in the literature survey. The reason for their importance, their different components and their inter-relationships are discussed. Suggestions are also given on how to implement them.

Some of these techniques were implemented in a fibre cement sheet plant and this is explained in the second part of the thesis. The most important application was reducing setup times on one of the machines. In this pilot exercise, setup times were reduced to 30% of their previous times. The author is confident that it can be reduced even further. An additional 10% should be the next goal. This makes the complete

application of WCM in the plant a very real possibility.

Finally suggestions are made on how to implement the rest of the pilot study. Once this is completed, the management of the specific plant will hopefully consider implementing WCM techniques throughout the plant.

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CHAPTER 1

INTRODUCTION

In 1910, when the Union of South Africa was formed, manufacturing produced 3,7% of the country's Gross Domestic Product(GDP). Agriculture accounted for 21% and Mining 28%. In 1988 Manufacturing produced 23,7% of GDP(the single largest share) and employed 1,3 million people. What is more, the industrial base had been widened and diversified to such an extent in recent years that, if necessary, South Africa could manufacture most, if not all, of its essential requirements. (Bureau for Information, 1989)

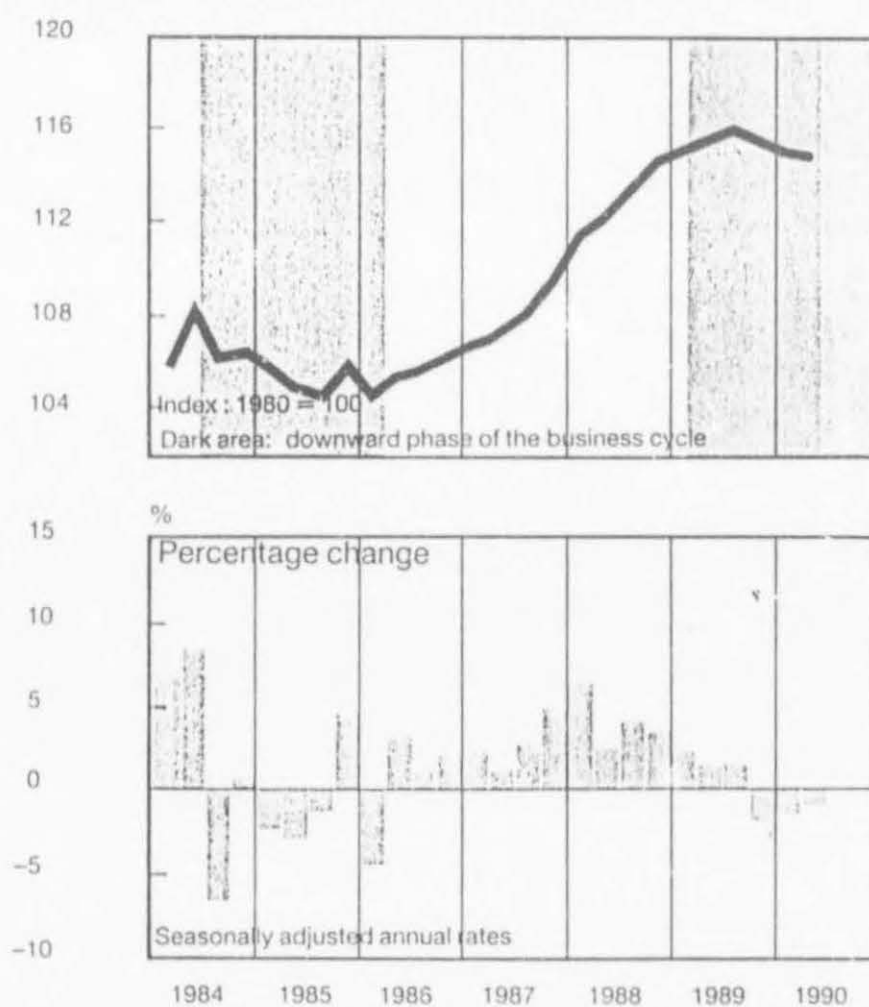
This development of the manufacturing industry was not a "natural" process but one prompted by outside factors. These included the discovery of gold and diamonds and the subsequent development of the mining industry; two World Wars which disrupted South Africa's traditional foreign supply lines and a spate of economic sanctions imposed world wide against South Africa. During this period South Africans of all races showed a large amount of enterprise and gained valuable expertise in modern manufacturing techniques.

It makes good sense to use our technical and labour resources to add value to the raw materials which our country has in abundance. A growth in the manufacturing industry should increase our GDP considerably and distribute the resultant wealth by supplying jobs to our many unemployed. It is obvious that this could become the

foundation of the future political stability of all of Southern Africa.

Unfortunately this is not happening. Figure 1.1 shows the GDP and percentage change in GDP for South Africa over the past five years. During the past 15 years an average annual growth in GDP of only 2,0% was achieved. This means an increase in job opportunities of only 1,0%. During the same period the country's population had

Figure 1.1 REAL GROSS DOMESTIC PRODUCT



(Source: SA Reserve Bank)

shown a growth of 2,5% per year. (Van Zyl, 1990) It is estimated that an annual increase in GDP of at least 4,0% is required for an acceptable political solution to the country's problems. It is obvious from these figures that our position is not favourable and it must be accepted that the poor productivity of our manufacturing industries is partly to blame for this situation. There can be little doubt that the survival of manufacturing in South Africa is in serious jeopardy.

Various reasons are often given for this situation. Some prefer to blame the government for too much control of the private sector; others on our third world workforce.

Johnson(1985) states that the responsibility for our appalling productivity lies with, as he states it, the "Captains of Industry", who tend to ignore the Manufacturing Task and delegate responsibility for its development to middle management. Middle management does not have the authority to implement the changes in company strategy which the Japanese have recognised as a prerequisite for survival.

The reason for the success of Japanese companies lies not in their marketing strategies or accounting procedures, but in the ability of their organisations to produce consistent high quality, functional goods at minimum cost, as and when the market needs it. Their management philosophy recognises that the manufacturing task is not just operational, but needs philosophies and long-term strategies

set in the boardroom. It also needs qualified people to execute these strategies.

These strategies have been implemented by Japanese companies and have helped them to become world leaders in the manufacturing industry. This is obvious from the price, quality, design and availability of Japanese products. These strategies are often referred to as World Class Manufacturing (WCM) techniques.

The aim of WCM is to reduce waste. Waste is defined as anything other than the minimum amount of equipment, materials, parts, space and worker's time which are absolutely essential to add value to the product. (Suzaki, 1987) With this in mind, Toyota has identified seven types of waste, namely:

1. Waste from overproduction
2. Waste of waiting time
3. Transportation waste
4. Processing waste
5. Inventory waste
6. Waste of motion
7. Waste from product defects

A World Class Manufacturer will thus constantly try to reduce this waste.

World Class Manufacturing consists of four separate, but inter-dependent parts. These are Just-in-Time, Total Quality Control,

Total Worker Commitment and Total Productive Maintenance. This concept is illustrated in figure 1.2. A manufacturer may wish to implement only one or two of these strategies, however experience in Japan, Europe and America has shown that only after having successfully implemented all four can a company really achieve the status of World Class Manufacturer.

Figure 1.2 THE FOUR COMPONENTS OF WORLD CLASS MANUFACTURING

World Class Manufacturing			
Just In Time	Total Quality Control	Total Worker Involvement	Total Productive Maintenance

This thesis aims to place World Class Manufacturing in its proper perspective and to make managements aware of its possibilities in the South African context. In particular it describes a pilot study in the manufacturing of fibre cement sheets. The fibre cement industry world wide is in a state of transition and company managements would have to consider making use of WCM techniques in order for their products to stay competitive. The author would go as far as to say that the survival of the fibre cement industry in South Africa depends on the extent to which top management implements WCM techniques.

Finally, recommendations are made on how to implement WCM techniques. These recommendations are specifically aimed at the fibre cement industry, but can be applied in most other industries as well. In particular, it can be applied to all other processes where raw materials are batch prepared and where continuous runs are required due to product features. The paper and food industries are examples of such processes.

The thesis is presented in two parts. Part I consists of a literature survey of World Class Manufacturing and is covered in chapters 2 to 5. Part II describes the practical application of some of these principles at a fibre cement sheet plant.

Chapter 2 describes the WCM technique of Just-in-Time (JIT). JIT is a manufacturing management philosophy which aims to reduce lead times and inventory to zero. Obviously this is not possible, but gives an indication of what to aim for. After discussing the advantages of JIT, the various features of the system are discussed. The chapter is concluded with a section on how to implement JIT in an organisation.

Chapter 3 examines Total Quality Control (TQC). TQC differs from traditional Quality Assurance in that it strives to reduce reject levels to zero and not to some "acceptable" level. JIT requires that no rejects are produced and is thus totally dependant on TQC. TQC in turn is seldom successful without the motivation to solve problems forced by JIT.

Chapter 4 investigates the question of worker involvement. Total Worker Involvement is one of the four building blocks of WCM and is just as important as the other three. All of the components that make up the WCM package require the shopfloor workers' participation in solving problems. It thus requires a high level of motivation from all the staff. After discussing the Japanese worker and his high level of commitment towards his company, the Black South African worker is examined in some detail to explain why he often reacts differently from what could be expected in the work situation. The Black worker is then compared to his Japanese counterpart. The chapter is then concluded with some examples of techniques that are available to improve worker participation.

Chapter 5 describes Total Productive Maintenance. Both JIT and TQC require machines to be in perfect condition when producing. Japanese maintenance managers aim to have machines and equipment in a better condition than when received from the suppliers. This not only requires carefully scheduled preventive maintenance, but also operator co-operation in daily cleaning and routine maintenance.

Chapter 6 gives an overview of the manufacturing of fibre cement sheets in South Africa and a description of the line that was used as a pilot study.

Chapter 7 describes how a reduction of setup times was achieved on the sheet machine. A reduction of setup times is one of the most important objectives to achieve before JIT and WCM can be

implemented successfully.

Chapter 8 describes the steps needed to implement WCM on a fibre-cement sheet machine. It shows the actions already taken and suggests further steps to implement.

P A R T I

LITERATURE SURVEY: WORLD CLASS MANUFACTURING

CHAPTER 2

JUST-IN-TIME

2.1 Introduction

Just-In-Time (JIT) is a manufacturing management philosophy which aims to produce instantly with perfect quality and minimum waste. Products are thus produced only when required and are therefore immediately available to the customer. This is an impossible goal to reach, but indicates the direction in which to strive.

JIT was developed in Japan out of necessity. Japan is small in size, poor in raw materials and has a relatively large population. It had also gained a reputation for poor quality products after the Second World War. All of this, coupled with a decreasing standard of living in Japan, led to the development of JIT.

Inadequate storage space and the high cost of interest on raw materials indicated that inventories had to be small. These included raw materials, work in process and finished products. This required production runs to be shorter so that customer demand could be satisfied. In order to have shorter production at a realistic cost, change-over times between products had to be shortened.

Product quality had to be increased to ensure that only ordered products were produced. Waste in all forms had to be reduced in order to make the JIT philosophy profitable.

JIT differs from traditional production planning in that production runs are kept as small as possible. Traditionally production planners aim to make runs of the same product as long as possible in order to keep costs down. The optimal run size is determined by making use of the Economic Order Quantity (EOQ) formula. (See figure 2.1)

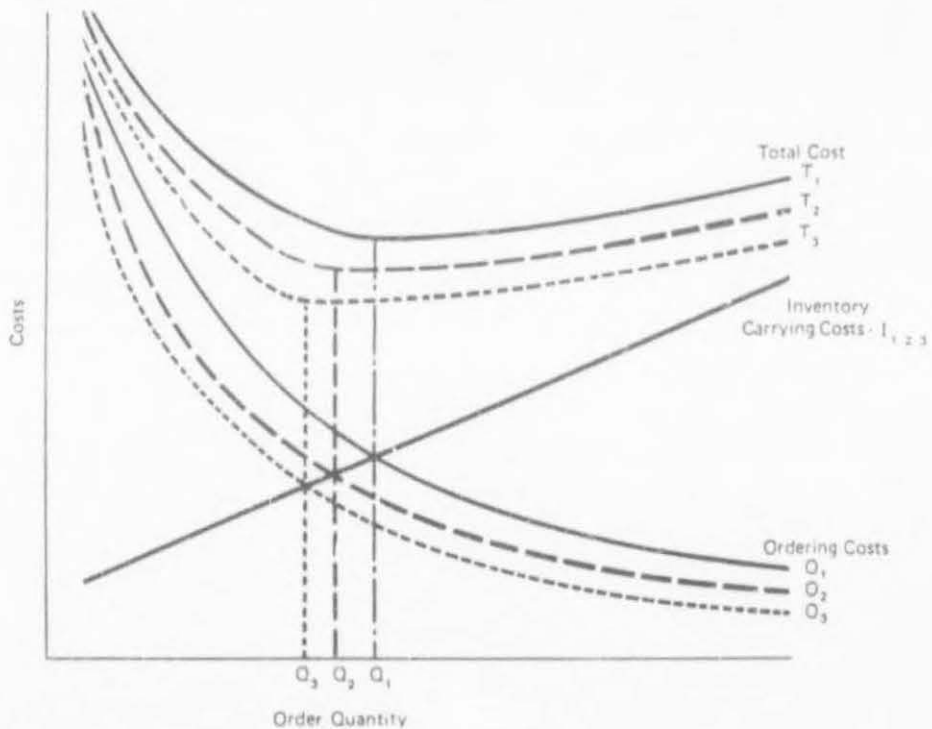
The EOQ formula assumes that the cost of producing products can be broken down into a fixed cost and two variable costs. The first variable cost is the ordering cost(O_1), and decreases as the order quantity increases. The second is the inventory carrying cost(I), and increases linearly with the amount of products per run. The total cost of production (T_1) thus reaches a minimum for a certain amount of products per production run. (Q_1) This point is known as the Economic Order Quantity (EOQ).

In traditional production planning theory it was assumed that the ordering costs were fixed as setup times could not be decreased. The cost of keeping stock was also often underestimated. JIT planners do not underestimate the cost of keeping stock and know that setup times can be reduced considerably.

If the setup cost can be reduced the ordering cost is reduced as

shown in figure 2.1. (Q_2 and Q_3) This causes a lowering in total costs (T_2 and T_3) and a reduction in the EOQ. (Q_2 and Q_3) The ultimate goal of JIT is to have an EOQ of 1. The only way to do this would be not to have any setup times at all. This can be achieved by having a dedicated machine for every product in the product range.

Figure 2.1 IMPACT OF REDUCED ORDERING COST
ON ECONOMIC ORDER QUANTITY



2.2 Features of the JIT System

Various features distinguish JIT from traditional production planning. The aim of this section is to give an overview of some of these features. The author feels that these are the most important

features that a manufacturer should be aware of. JIT can be applied in an office environment or a service industry as well. If the reader requires information on these applications or further information on the features discussed here, it is suggested that the list of references at the back of the thesis be consulted .

2.2.1 Setup time reduction

It is obvious from the previous section that setup time reduction is one of the most important features of the JIT system. Reducing setup times makes short production runs more economical .

Reducing setup times on machinery should be tackled on a project basis and worker cooperation should be obtained from the start of the project. Experience has shown that setup times can be decreased dramatically if all concerned contribute to the project. Shigeo Shingo of the Japanese Management Association quotes examples of setup times being reduced to 1/63 of what they used to be. (Shingo, 1987)

Other examples that he quotes include die changes on presses (1/19), plastic moulding (1/24) and die casting (1/13). He states that all of these successes were achieved only through a change in thinking and attitude.

Shingo refers to his method as Rapid Tool Setting (RTS). It consists of classifying actions, reorganising the setup procedure

and improving housekeeping. He states that RTS has the following positive effects:

- (i) The operation ratios of machines will improve.
- (ii) Small lot production will become possible.
- (iii) Urgent work can be promptly undertaken.
- (iv) Special skills will not be required.
- (v) Defective tool setting can be eliminated.
- (vi) Production changes and tool setting will not be disliked.
- (v) Yield ratios of material will be increased as no trial runs will be required.
- (vi) Tools will be tidily stored.

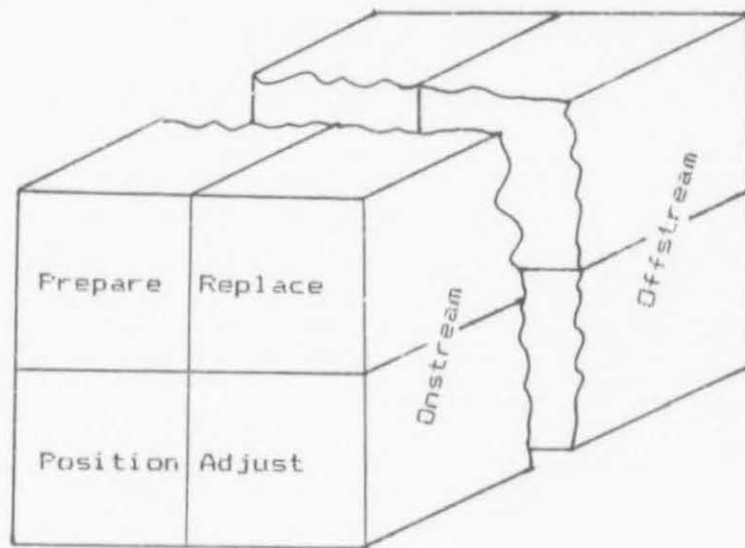
According to Shingo changing from one product to the next on a production line consists of four basic steps:

- (i) The preparation of the new tools and equipment to be used.
- (ii) The replacement of the tools and equipment.
- (iii) The correct positioning of tools and equipment.
- (iv) The adjustment of the machines so that the products produced conform to specifications.

In general preparation takes 30% of the total time to change, replacement 5%, positioning 15% and adjustment 50%. All of these steps are normally performed both onstream and offstream as indicated in figure 2.2.

Shigeo recommends that RTS be implemented in three stages as indicated in figure 2.3. Before implementation offstream and

Figure 2.2 THE COMPONENTS OF SETUP TIME

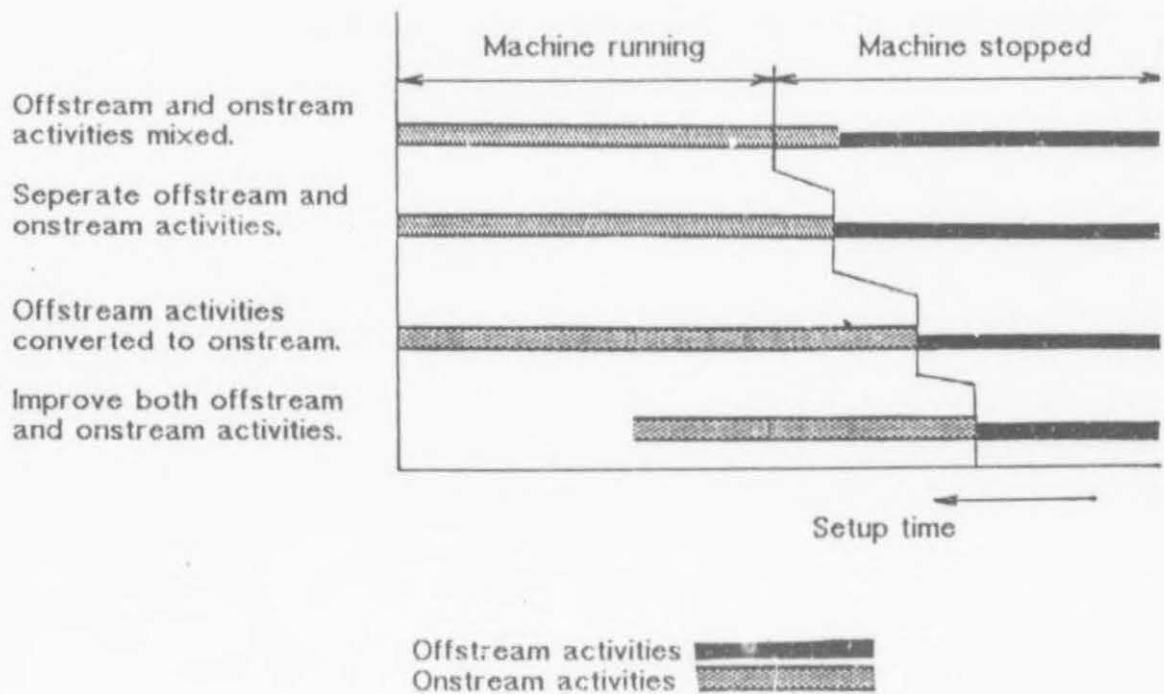


onstream activities are intermingled. The first stage would thus be to identify and separate the offstream and onstream activities. The second stage would be to convert as many as possible offstream activities to onstream. Finally both onstream and offstream activities need to be improved.

The first step in improving a setup time would be to review the setup operation and time each component of the operation. Each component must then be classified as either onstream or offstream.

Converting offstream activities to onstream consists of identifying all activities that are presently performed while the machine is stopped, but could be performed while the machine is in operation.

Figure 2.3 IMPLEMENTING RAPID TOOL SETTING



These activities are then to be scheduled to be performed while the machine is running.

Preparation activities can be improved by improving transportation and storage methods. Tool replacement can be improved by installing quick release equipment, hydraulic clamping equipment or single operation equipment.

Adjustment can become totally unnecessary through functional standardisation, i.e. all tools have identical critical dimensions.

It is suggested that a chart is placed at the work place, indicating the setup times over a period of time. In this way the workers will see the improvement in setup time and be motivated to contribute ideas to the project.

Parallel operations are another way of reducing setup times. This can be achieved by assigning additional workers to assist in the setup. Workers then work in teams, doing the same work, often on opposite sides of the same piece of equipment. Parallel operations save walking distances and time and create a spirit of teamwork. It is suggested that use is made of PERT to develop parallel operations.

A video camera can be used to record the setup, both before and after improvements. These recordings can be used to review the sequence of operations and can also be used as training and motivational aids when other setup time reduction projects are launched.

It must be realised that time lost due to production changes only contribute to higher costs and should thus be kept as short as possible. This can be attained by making use of the RTS principles.

2.2.2 Inventory

Having no or little inventory is central to the idea of JIT. JIT is

often referred to as zero inventory or stockless production. As inventory only contributes to operating cost, it is one of the wastes that should constantly be minimised.

The philosophy recognizes that there is a certain minimum level of inventory which must be carried to satisfy a company's marketing strategy and existing operating conditions. Zero inventories or stockless production are thus not the correct terms to use when describing JIT.

JIT does not eliminate inventories, it reduces them to an economical level. Companies still need buffer storage between production processes, but these should be as small as practically possible. This stock should also be located as close as possible to the next point of use. Intelligent use of storage systems can help manufacturers achieve this goal and maximise productivity.

Inventory reduction is also used as a means of enforcing production improvements. Having little or no buffer stock forces the upstream process to deliver perfect quality at a constant rate. Any problem in a process will immediately become visible instead of being hidden by excess inventory. Management should thus constantly decrease the amount of allowable buffer stock until a problem appears. After solving the problem the inventory reduction should continue. The analogy of a river is often used to explain this process.

The level of inventory in a factory is compared to the level of

water in a river. As the level of the water decreases, rocks become visible which pose a threat to boats on the river. These rocks represent production problems. Instead of increasing the level of the water, the rocks should be removed. The idea is to make the river passable with as low as possible a level of water.

Lowering inventory levels has the following advantages to a company:

- . lower cost of capital tied up in inventory
- . lower storeroom costs such as facilities, equipment and labour
- . less need for sophisticated inventory control systems and paper work to track the inventory
- . less need for inventory control staff
- . lower tax, pilferage, risk of obsolescence
- . less floor space which enables machines to be situated closer together with a resultant saving in materials handling.

It can thus be seen that producing just in time, has many more advantages than producing just in case as practised in many South African factories.

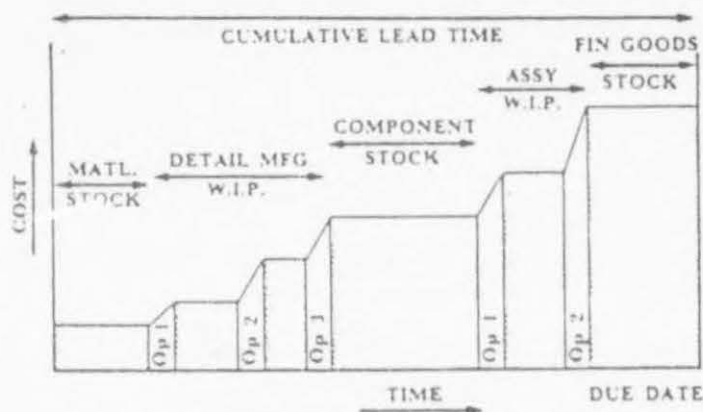
2.2.3 Lower Lead Time

One of the objectives that are set when implementing a just in time system, is to produce products only when they are required. This has the advantage of lowering inventory levels as discussed in the previous section. It also has a further advantage in that it makes a production plant more manageable with less

wastage occurring.

Figure 2.4 shows how many organisations currently manufacture their products. Material is ordered from suppliers and put into stock, either because it was ordered in an economic order quantity or the supplier or transporter is not trusted to deliver it when required.

Figure 2.4 THE REAL COMPONENTS OF LEAD TIME



After a time it is launched towards the first operation on the routing. Unfortunately it goes into Work in Progress once the operation is completed. After a while the second operation is started but once again it goes into work-in-process after the actual operation.

After detail manufacturing is completed the article is typically placed into component stock. Normally more components are manufactured than required either because it was an Economic Order

Quantity or provision was made for a certain percentage of scrap and breakages. The required articles will wait in component stock for their mating parts; the excess parts might never be used. The material thus struggles through the business in this slow fashion until it is hopefully all dispatched to a customer.

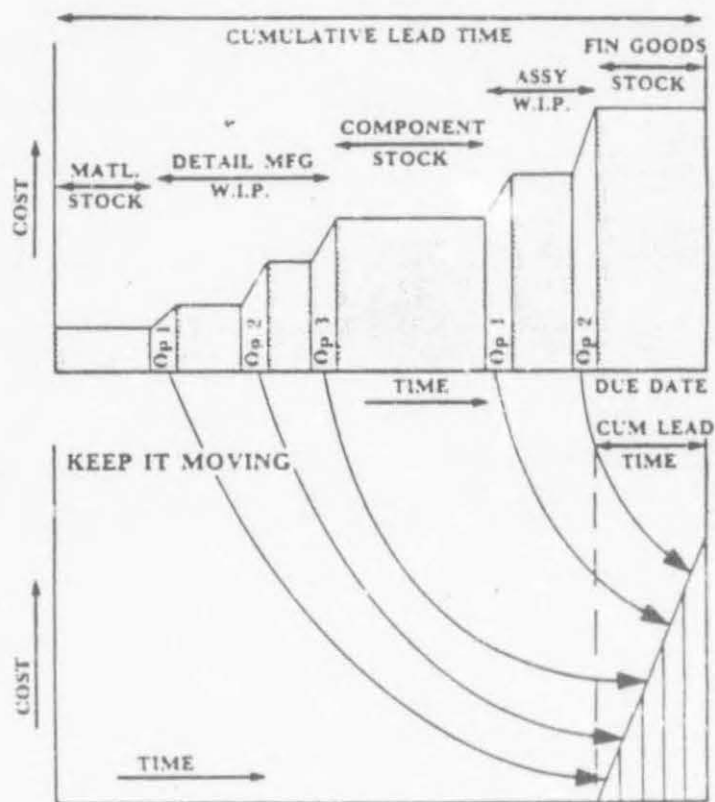
This illustrates the traditional management value which states: "The sooner the job is started, the better the chances are of getting it finished on time." What happens in fact is that the longer the lead time becomes, the more work goes into WIP and the better the chances are that shop supervision will do the wrong job first. Our new value should be: "Schedule the start of the job the shortest possible time ahead of its need date." (Johnson, 1985)

This value is the core of the JIT philosophy. Adoption of this philosophy will reduce lead times and inventory. This will change the description of current practices as shown in figure 2.4 to the situation shown at the bottom of figure 2.5.

The real lead time is thus not the sum of all of the various operating times as traditionally taught, but the time the material takes to move from supplier release to dispatching dock. The easiest way to calculate the real lead time would be to make use of the Irrevocable Inventory Law which states that:

$$\text{LEAD TIME} = \frac{\text{INVENTORY}}{\text{OUTPUT RATE}} \quad (\text{Johnson, 1985})$$

Figure 2.5 LEAD TIMES IMPROVED



Inventory in time units provides a very good diagnostic tool to direct our attention to the actions we need to take to move progressively towards the goal of JIT - "Instantly manufacture the product when the customer needs it." (Johnson, 1985)

2.2.4 Kanban

To many people the terms Just-in-Time and Kanban are synonymous. Closer analysis, however, reveals that the Kanban system is a subsystem of JIT. Kanban is an information system which facilitates the controlled flow of material between one workstation and the

next.

The Japanese word Kanban literally means "ticket", "card" or "visible record". This visible record, often represented by a card, authorizes production or transfer of parts from one work centre to another. This card is usually attached to a standard container and contains information on the product, producing work centre, consuming work centre and route.

The flow of material is always associated with the relationship between two work centres. Material may not be moved between work centres without a Kanban. Similarly work may not be performed on a product without the authorization of a Kanban. The total quantity of material in the system is thus controlled by the number of Kanban in the system. A reduction in the number of Kanban in the system will result in a reduction of inventory.

There are two types of Kanban systems, the dual card and single card systems.

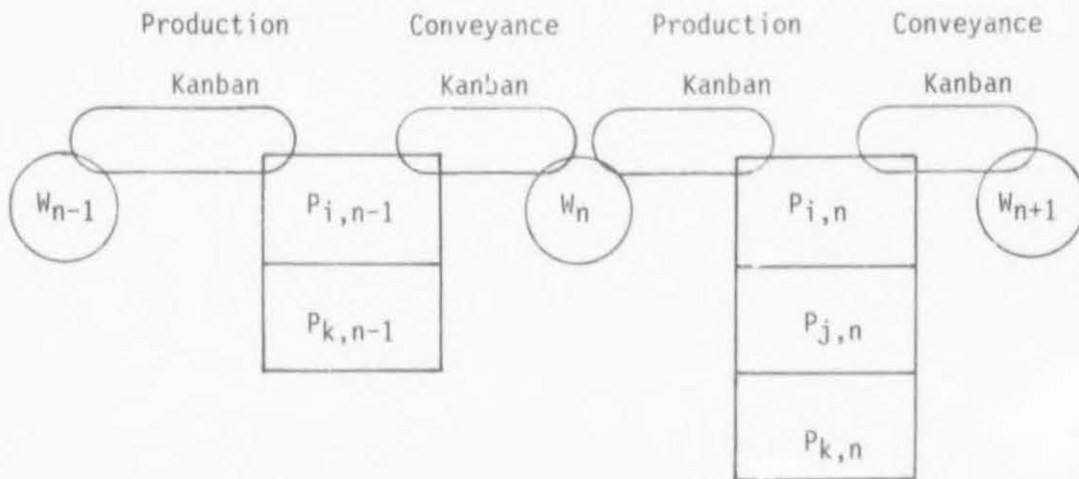
The dual card system was developed by Toyota and consists of "conveyance" Kanban and "production" Kanban. As seen in figure 2.6, material flows from work station W_n through an intermediate storage area to work station W_{n+1} . All material is moved in standardised containers, each holding approximately one-tenth of a day's output. Each container has a Kanban attached.

All inventory in the storage area has a production Kanban attached and cannot be removed until a material handler arrives with a conveyance Kanban. Once this occurs, the production Kanban is removed from the container and handed over to the producing department. This serves as an authorization to replace the material just removed.

The conveyance Kanban is then attached to the container and the container is moved to work station W_{n+1} . Here the articles in the container are consumed. Only when the container is empty, may the conveyance Kanban be removed and returned to the storage area to acquire more material. The production of additional inventory is thus delayed until the current inventory is used.

In the simpler and more common single card system, parts delivered to a subsequent work station are controlled by one Kanban instead of two. As in the dual card system the number of Kanbans controls the number of containers of work in progress and thus the inventory level. As a container is emptied of parts at the second work station, the container and the Kanban is returned to the preceding, or first work station. Here the Kanban authorizes production of another container of parts.

Figure 2.6 FLOW OF MATERIALS WITH THE DUAL CARD KANBAN SYSTEM



W_n = Work station n

$P_{i,n}$ = Part i processed at work station n (Hahn, 1983)

Although the single card system is easier to understand and use, it does not offer the same level of control at the preceding work station that the dual card system offers. The single card system can be used with confidence though where only one or a few parts are produced in a given work station.

A printed card is not necessarily the only type of Kanban that can be used. In certain instances the container can be the Kanban. An empty container would authorize the production of new parts. The amount of permissible inventory can then be controlled by restricting the number of containers in the plant. Painted squares at the work station are also used as Kanban. Parts for the work station are kept in a designated area on the work table and as long

as the painted section is covered, the preceding work station is not authorized to make parts. As parts are used from the designated area, the painted square becomes visible and authorization is provided to produce more parts.

Kanban is a "pull" system compared to the traditional "push" system used in the West. As a user work station uses parts, the empty containers and Kanban are returned to the preceding supplier work station. Only then may the supplier produce more parts. Thus the user triggers supplier production. In the traditional "push" system the supplier would produce parts at a steady rate, whether the user is able to use it or not. This creates bottlenecks, work in progress inventories and a crowded factory.

In order for JIT to be truly operational in a factory, the concept of a supplier work station should be carried through to the raw material vendor and the concept of a user work station to the client. The raw material supplier should thus receive Kanban to authorize the supplying of material. In the same manner the client should issue a Kanban to receive a finished product. The advantage of such a system is that it drastically cuts down on the amount of paperwork required. Kawasaki in Japan for example, pays their tyre supplier not according to the number of tyres ordered during the month, but according to the number of motorcycles built during the month. As there is no internal stock in their factory, Kawasaki and their supplier know that all tyres received are used immediately.

2.2.5 Purchasing

One of the basic JIT objectives is to minimize Work in Process and raw material inventories. This is done by ensuring that every work station receives the exact quantity of parts or material at the precise time it is needed. JIT users therefore strive towards a "stockless" production system where each unit of output is produced as it is needed. This requires heavy involvement of the purchasing department as purchasing is where the flow of materials begin.

In just-in-time purchasing, suppliers are required to deliver small batches of high quality parts or material direct to the user's plant when required. This can mean daily or even hourly deliveries of purchased material.

It is important that the supplier can supply under the following conditions:

- . Reduced order quantities
- . Frequent and reliable delivery schedules
- . Reduced and reliable lead times
- . Consistent high quality levels.

Reduced order quantity and frequent deliveries seem to be in direct contradiction with the traditional purchasing management philosophy which favours buying in bulk. However, when the fundamentals of purchasing management are examined, it is found that JIT purchasing is in fact well founded on the same theories.

Traditional inventory theory states that the order quantity is a function of the usage rate, inventory carrying cost and the reorder cost. These factors are used in the Economic Order Quantity (EOQ) formula, as discussed in section 2.1, to determine the order quantity. Applications of the EOQ formula often treat the unit re-order cost as a fixed value which is assumed to be constant. In reality this is often an incorrect assumption. With JIT purchasing the re-order cost can be reduced to produce a smaller optimum order quantity.

The cost of ordering parts or material from a supplier can be broken down into six components. These are:

- (1) Negotiating cost
- (2) Converting a planned order to an open order.
- (3) Expediting cost
- (4) Receiving count cost
- (5) Receiving inspection cost
- (6) Transportation cost

In the JIT purchasing system, a vendor who meets the rigorous JIT purchasing requirements is classified as a Class A vendor. Class A vendors receive long-term contracts and are often the only suppliers of a given part, or family of parts, to a user. They are thus exempted from all of the above costs except (1) and (6). Both the negotiating and transport costs can be significantly reduced. The new ordering cost makes it possible to order smaller quantities more often.

Developing long term vendor relationships, rather than consistently seeking short term price breaks, is contrary to the normal way business is done. The advantages obtained become obvious when the vendors' capacity capabilities, process capabilities and quality performance become known. This results in the saving of the first five components of the order cost.

The transportation cost can be reduced by selecting vendors geographically close to the user and by ordering families of parts from one vendor. Ordering families of parts will make it possible to order parts in truck or carload quantities.

One of the results of JIT purchasing is that the user's supplying vendor base will shrink. Most purchasing managers will feel uncomfortable with this, as present purchasing philosophy states that multiple sourcing reduces the risk of supply disruption and that active competition holds prices down.

The risk of supply disruption will be reduced significantly if the user company takes an active interest in the vendor. In Japan it is not uncommon for large users to assist vendors in difficult times. This could include financial assistance, technical advice or even supplying labour during industrial strikes.

A Class A vendor should also not be more expensive than a vendor on the open market as he, unlike his competitors on the open market, enjoys the economy of scale. A short term contract involves a high

degree of risk, and is thus associated with higher costs. In addition a supplier with a short term contract does not have sufficient incentive to make any long-term cost-saving investments.

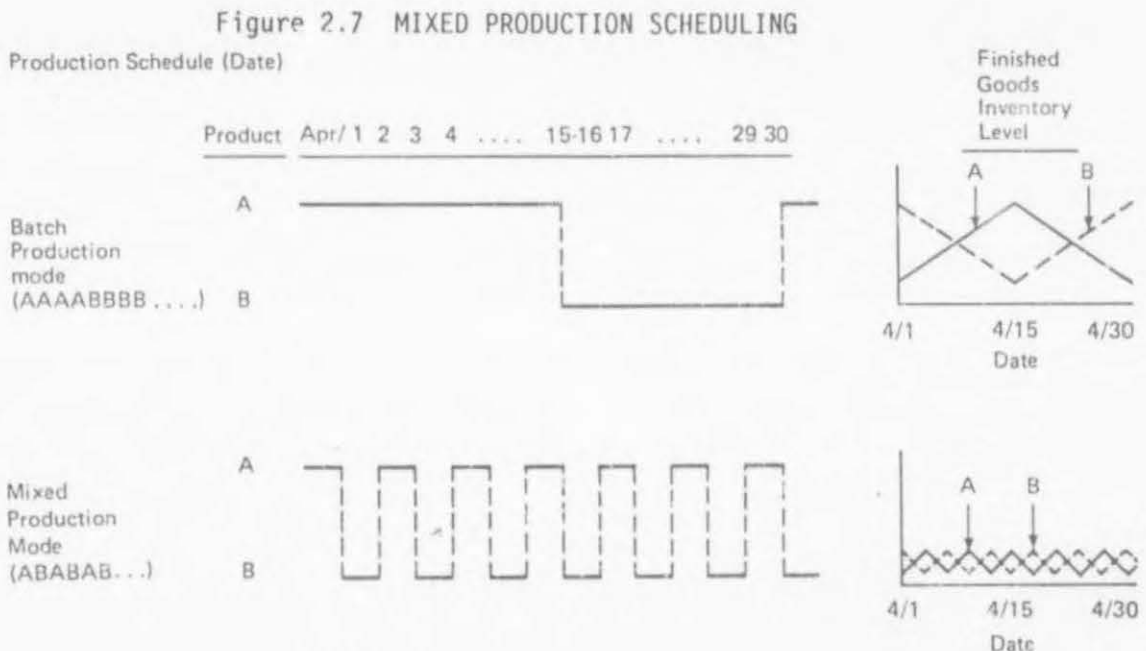
2.2.6 Mixed Production Scheduling

One of the most important lessons that the manufacturing industry has learned during the past decade, is that the customer is responsible for its success. In the 1920's Henry Ford remarked that the customer could have any colour Model T, as long as it was black. This attitude prevailed during the following 50 years where mass manufacturers produced standard, identical items. The argument was that limiting product ranges would keep operating costs down, by eliminating changes in production runs.

This situation was acceptable until the late 1970's, when increased competition and diversified customer needs forced manufacturers to offer a range of products to their customers. Today a manufacturer's ability to respond quickly to the market is a matter of survival.

This creates a problem in traditional assembly lines where the same product is often produced for hours or even days before the line is changed to the next product. Frequent changeovers are unpopular due to the time wasted. The result is large quantities of finished stock as the customers normally buy at a steady rate. This is illustrated in figure 2.7(a). The risk of overproduction is also very large.

If different products are produced every day or every hour or even every minute, it would be possible to produce at the rate at which customers buy. The finished goods inventory would thus be significantly smaller. This is illustrated in figure 2.7(b). Use must be made of the setup time reduction techniques as described in section 2.2.1 to achieve this mixed production scheduling. Mixed production would also reduce the risk of overproduction on any one particular product.



2.2.7 Uniform Workloads

Mixed production at final assembly should be scheduled to match the market demand profile. The daily or hourly schedule should be constant over the monthly or weekly planning horizon and should have the same product profile. The result is that parts are required from upstream activities at a steady rate. This uniform workload at all

activities is very important in managing a factory as each person engaged in production will be able to control his area with certain expectations.

Yasuhiro Monden (1981), gives the following example to explain the above concept in more detail:

At the Toyota plant, the Corona line has to produce 4 types of Coronas during the following month. They differ in engine size, shape and colour. The monthly demand for each type is shown in table 2.1. There are twenty working days during the month and each day is eight hours long.

Table 2.1 Toyota example

Types	Monthly demands	Daily average output	Cycle time	Ordinal Schedule
A	8000 units	400 units	2,5 min	4 units/10 min
B	6000	300	3,3	3
C	4000	200	5,0	2
D	2000	100	10,0	1
Total	20 000	1000	1 unit/min	10 units/10min

Traditional production planning techniques would require that all 8000 type A's be produced first, the line changed to produce type B, and then all 6000 type B's produced etc. This would give the least amount of time lost due to production changes.

The disadvantage would be that large numbers of finished stock would have to be carried to satisfy customers for types B, C and D while type A is produced.

A second disadvantage would be that if for example, type A is a two door model and the other types are four doors models, a change in output from the door assembly line will be required after the type A run is completed. This might not seem like a big disadvantage, but if it is considered that the Corona range in fact consists of over 4000 different combinations of models, the amount of planning involved becomes enormous. The solution to the problem would be to produce the same amount of each type of car every day. This is indicated in the third column of table 2.1.: produce 400 of type A every day, change to type B, produce 300 of type B etc. If changeover times are reduced as described earlier, loss of production due to changeovers would be minimal.

The advantages of this solution are obvious. Firstly less finished stock is required to satisfy daily customer demand, as the plant produces at the demand rate and profile. The second advantage is that the door assembly line, and all other upstream operations, work at a constant daily rate. Planning their work thus becomes much

easier. As a result, management thus has more time to concentrate on problem solving. Toyota has in fact taken this solution one step further by calculating the cycle time for each of the types. (See table 2.1)

$$\text{Cycle time} = \frac{\text{daily operating time}}{\text{daily average output}}$$

By using the cycle time an ordinal schedule for the various types of Coronas is prepared. In this case it was decided to produce the cars in groups of 10 every 10 minutes. A possible production sequence could be: AAAA, BBB, CC, D. This sequence would then be repeated throughout the production month and so allow the upstream operations to work at a even steadier rate.

A more complex arrangement of the above ordinal schedule could also be: A, B, A, C, A, B, A, C, B. This would give even steadier conditions in the upstream processes. In fact, there are various ways to arrange the ordinal schedule. When it is taken into consideration that the Corona line produces more than 4000 types of Corona, it becomes obvious that obtaining the optimal ordinal schedule of mixed production is somewhat difficult. Toyota is trying to solve the problem by applying a heuristic computer program. (Monden, 1981)

2.2.8 Adapting to Fluctuating Demand

Very few industries have a steady demand for their product. Demand

for a certain product could be dependent on the state of the national economy, season, time of the year or even time of the month. It is often the function of the marketing division to predict this variation so that plans can be made in advance to cope with it. As can be expected, these predictions are seldom correct. The result is either over or under production. In the case of over production a large finished product inventory is produced with resultant costs. In the long term staff retrenchments are often the only solution to the problem. In the case of under production, customer letdowns occur which may cause the company to lose market share to competitors. It is thus important that production should be able to adapt quickly and smoothly to changes in demand. Levelled/mixed production, as described in the previous two sections, allows a JIT manufacturer to do just that. Monden (1981) uses two cases to discuss this.

Case 1

Case 1 involves adapting to demand changes during the year. I.e. where production has to be increased or decreased from one month or week to the next. Ordinarily the load on a machine is set at only 50% of its capacity. This can be done by having a worker handle more than one machine at a time (described in section 2.2.9). When demand increases, temporary workers are employed to increase the loading of machines. It is however, necessary to have machines that even a newly hired, unskilled labourer will be able to become fully capable of operating within three days.

On assembly lines the cycle time can be increased by increasing the number of tempory workers. If, for example, one worker has handled the job with a cycle time of one minute, two workers would be able to achieve a cycle time of thirty seconds.

Adaptation to relatively short-term increases in demand can be achieved by introducing overtime. Overtime should not become the norm though, as returning to normal time could be considered a cut in pay, with resultant loss in morale.

On the other hand, if demand decreases, adaptation is more difficult. The first step would be to dismiss the temporary workers. If this does not decrease output sufficiently, permanent staff should be removed from production and occupied with something else. It is better to let redundant workers take a rest than produce unnecessary stock. The life-time employment principle, prevents World Class Manufacturers from dismissing permanent staff. (See section 4.3.1) The following are examples of activities that may be organised during a slack period:

- . Quality control training.
- . Practising set-up actions.
- . Maintenance and repair of machines.
- . Manufacturing improved tools.
- . Performing duties previously done by outside contractors.
- . Manufacturing parts previously purchased from suppliers.

Companies in Japan have even been known to use production workers as door to door salesmen in order to improve sales.

Case 2

Case 2 involves minor adaptations to demand within a month or week. As explained before, an ordinal schedule is drawn up at the start of every month. This schedule shows the daily operating pattern for the final assembly line only. As JIT is a pull system, it is not necessary to communicate this schedule to the rest of the operations, as they simply react to the Kanbans they receive.

When a change in customer buying pattern occurs during the month, it is once again not necessary to inform everybody. Only the ordinal schedule of the final assembly line has to be adjusted and the rest of the operations will follow. This simplicity is one of the major advantages that the Kanban system has over other production planning systems.

2.2.2 Factory Layout and Flow of Material

One of the seven wastes identified by Toyota, is transportation. Transportation adds no value to a product and should be minimised. This can be achieved by having machines and processes properly placed in the factory. An effort must be made to move away from a process-oriented layout towards a product-oriented layout.

In a process-oriented layout, machines are grouped together according to their function. Thus all the lathes would be in one part of the factory, all the presses in another and so on. This

layout is done in the belief that similar types of machines should be grouped together so that operations can be controlled by one supervisor. The disadvantages of such a system is unnecessary transportation, long lead times, high work-in-process inventory and difficult production coordination and scheduling. Figure 2.8 illustrates this by showing the material flow in a process-oriented layout.

In a product-oriented layout, machines are grouped according to the routing required for a product or a family of products. Figure 2.9 shows an improved layout. Material flow is much smoother and follows the sequence of processes required for a specific product. There is thus less confusion on the factory floor about which process comes next and what work gets priority. As the various processes are located more closely, much less transportation is required.

A product-oriented layout might create a few problems, however, and these should be considered carefully before implementation. Machine operators may become confused about whom they report to. They will not receive the same amount of specialist training that they would in a process-oriented layout. A certain amount of flexibility is lost when machines break down, as other machines can not be substituted easily. Carefull planning is required to minimize these problems, but experience has shown that the advantages of a product-oriented layout far outweigh the disadvantages, especially in JIT manufacturing.

Figure 2.8 MATERIAL FLOW IN A PROCESS ORIENTED LAYOUT

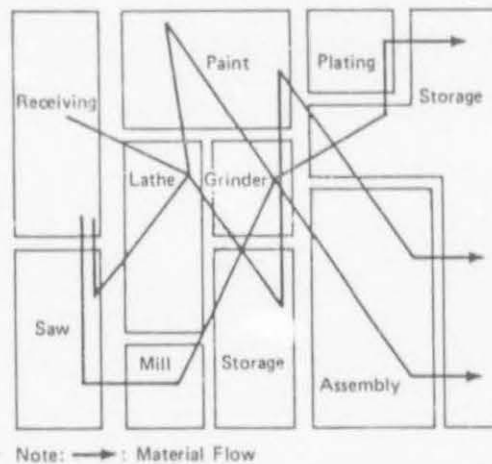
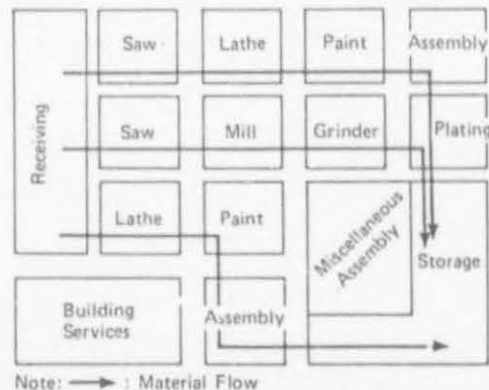


Figure 2.9 MATERIAL FLOW IN A PRODUCT ORIENTED LAYOUT



In a product-oriented layout workers are often required to operate different machines, depending on the product mix. This requires that machines are made easy to operate and foolproof. It also requires constant cross training of workers.

A U-shaped layout is typical of a JIT factory. It is particularly suited for long runs of the same product and optimises an operator's walking distance where he has to operate more than one machine. (See figure 2.10) It also enables operators to produce and transfer parts one at a time. If machines are laid out in a line, operators may feel that too much walking is tiring and may start producing in a batch mode. In a U-shaped line the operator does not have to walk far to reach all of the processes. He would thus load a part in the first machine, start it and move to the second machine. Here he does the same and moves on again. By the time he gets back to the first machine, it would have completed its operation and stopped. He then removes the part from the machine and takes it to the second machine etc. A certain amount of low-cost automation has to be performed on the machines in order for them to work unattended.

A major advantage of U-shaped layouts is their adaptability to changes in production tempo. Increases in production can be obtained by having more operators on a specific line. Operators could either follow each other around the line (the "rabbit chase" principle) or each move in their own circle and operate only a few of the machines. These principles are illustrated in figure 2.11.

Figure 2.10 COMPARISON OF LINE LAYOUT AND OPERATOR

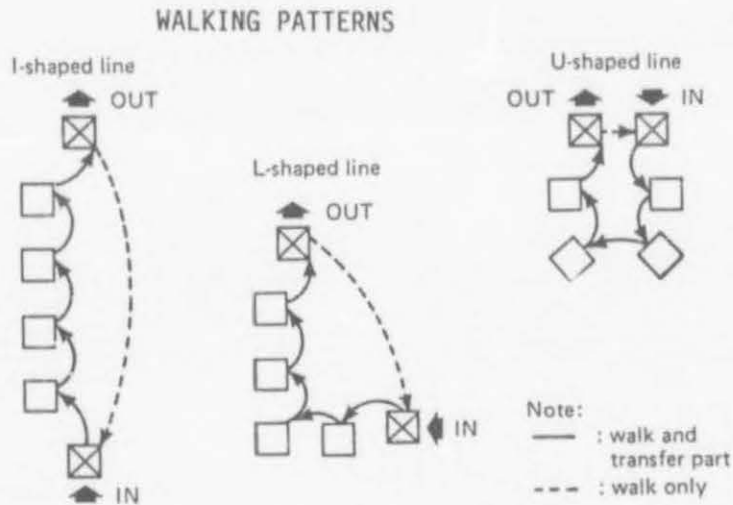
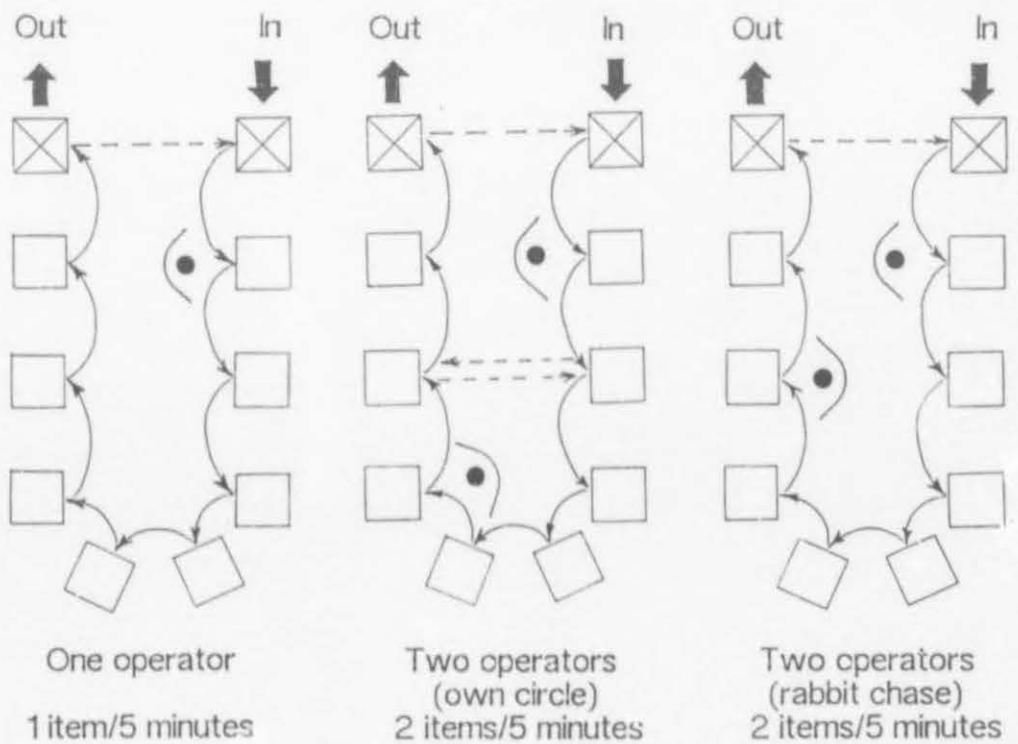


Figure 2.11 INCREASING THE OUTPUT BY INCREASING THE NUMBER OF OPERATORS



2.3 Implementing JIT

The process of implementing JIT in a factory has been investigated by various JIT experts. Although their final recommendations may not agree, they all agree on the following:

- . JIT requires total commitment from everybody in the organisation. In particular top management must be dedicated to its success. Without the backing of top management, JIT is doomed to fail.
- . JIT is a philosophy which aims to produce instantly, with perfect quality and minimum waste. It should be realised that this goal will never be reached, nonetheless the JIT philosophy requires a constant striving towards this goal. Toyota has been using the JIT system for nearly twenty years, yet continuous improvements are still being made, as true Just-in-Time manufacturing has not been achieved everywhere.

If one combines the recommendations of the above mentioned experts one arrives at the conclusions set out below. (It is suggested, however, that any prospective JIT implementor uses only those points applicable to his situation and discards the rest.

In Chapter 8 these points are covered in more detail when the implementation of JIT and World Class Manufacturing at a fibre cement sheet plant is discussed.

2.3.1 The Pre-implementation survey

Wheeler (1986) states that analysing the present situation carefully, contributes to a more efficient implementation. His two-month review and readiness assessment will indicate which areas will benefit most from JIT implementation. It will supply a baseline against which future successes can be measured. It will also indicate whether the climate within the company is conducive to JIT and whether sufficient skills are available to implement JIT.

2.3.2 The Pilot Project

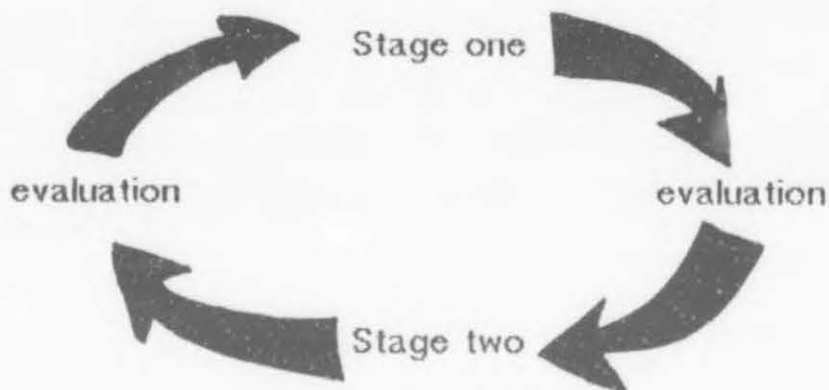
It is suggested that a pilot project be launched in an organisation where the JIT concept is unknown. This has two advantages. Firstly the advantages of JIT can be demonstrated to all concerned, especially top management. This is very important since JIT can only be implemented successfully if top management commitment and assistance is obtained. Secondly the pilot project can be used to train personnel involved in future projects. It is thus important that the pilot project is chosen carefully. It should be the application with the largest chance of success. Failure of the pilot project would mean the end of JIT in an organisation.

2.3.3 Implementing the Features of JIT

The various JIT features should be implemented in a cyclical manner, i.e. implement one or more of the JIT features, evaluate the

results, implement more features, evaluate etc. Professor Bicheno (1986) suggests that the implementation cycle be implemented in two stages. This is indicated by figure 2.12.

Figure 2.12 THE JIT IMPLEMENTATION CYCLE



Stage 1 creates a structure in which to implement JIT. It consists of such activities as re-designing the factory layout, reducing setup times, implementing Total Quality Control and Total Preventive Maintenance, installing small machines and improving product design. All of these activities can be implemented separately and need not form part of a JIT implementation strategy. They offer sufficient advantages on their own to merit implementation.

Stage 2 takes the structure created in Stage 1 and develops the process of producing only as needed, with minimum waste. Stage 2 thus represents the leap into full JIT. It consists of such activities as training multi-function workers, forcing improvements, implementing Kanban, reducing lot sizes, changing vendor

relationships and reducing stocks.

2.3.4 Evaluation

It is important to evaluate the result of every implementation stage and compare improvements against the baseline obtained in the pre-implementation study. This has the following results.

- . It is possible to see if any improvements occurred
- . The financial advantage compared to the cost of the improvement can be used to decide if further improvements in that area is feasible.
- . It can be used as an aid to motivate workers towards further improvements.

It must be stressed again that evaluation is not the end of the JIT implementation. The cycle continues and never ends. True JIT is never achieved, but it must constantly be strived for.

CHAPTER 3

TOTAL QUALITY CONTROL

It can be seen from the chapter on JIT, and its definition, that the implementation of Total Quality Control (TQC) is a prerequisite when implementing JIT. TQC implies that products are produced correctly the first time and that no rework is required. As JIT is totally dependant on TQC to work, quality should be one of the most important production objectives. JIT may be one of the most important features of WCM, but it needs TQC to be successful.

Although TQC is a requisite for JIT, the opposite is not necessarily true. A manufacturer may wish to implement a system of TQC with the resultant savings, without implementing JIT. Practice has shown, though, that few companies can successfully implement TQC without the motivation to solve problems forced by JIT. The two systems definitely complement each other and where possible should be used together.

3.1 TQC compared to traditional Quality Assurance

One of the wastes identified by Toyota is the waste of defective goods. TQC strives to minimize or even eliminate this waste by ensuring that only perfect quality products are produced. TQC, as devised in Japan, thus strives to reduce the number of rejects produced to zero. Japanese companies who practise TQC, no longer measure their defect rate in percentages, but in ppm. Certain

companies have even managed to produce defect-free products for up to six months. The advantages of this are twofold:

(i) A saving is made by not despatching poor quality products to the customer (Loss of customer goodwill, penalties, loss of contracts, legal fees etc)

(ii) A saving in production cost per product is achieved (producing rejects costs money, but generates no income.)

The major aim of most QA departments in Western (and South African) companies seems to be the detecting of defective products and preventing these products from reaching the customer. Although QA managers may deny this, a major part of their department's resources go into the inspection of finished products and very little is spent in preventing these defective products from being made.

This has the following effects:

- The function of the QA department is seen as that of a policeman. Production personnel then start to view QA as an enemy or at best as a nuisance, while it should be seen as a ally in the fight against waste.
- Faulty products are detected, but no corrective action is taken to prevent these products from being produced.
- More severe inspection improves the output quality, but does not improve the defect rate.

Traditional QA often makes use of statistically proven sample inspections. In this method a statistically calculated number of items are inspected from every batch. If a certain number of items pass inspection, the batch is assumed to be of acceptable standard. If the number is less, the batch fails and is either rejected or a 100% inspection is performed on the batch. This method of inspection has its advantages, mainly when destructive testing is required, but it also has the following disadvantages:

- It is assumed that a certain number of rejects will be inspected and passed as acceptable.
- This accepted reject rate could even be higher than anticipated if rejects appear in groups and the sample misses the group.

The purpose of TQC is to change the traditional QA system from "faulty product detecting" inspection, to "not making faulty product" inspection. This is done by using many of the Western QC principles and techniques, but also by using a group of techniques developed in Japan for TQC. These include 100% Inspection, Less than Full Capacity Scheduling and Total Preventive Maintenance.

3.2 Defining responsibilities for TQC

The basic precept of Japanese TQC states that: "The responsibility for quality rests with the makers of the product." (Hahn, 1983) Quality control thus becomes a basic production objective requiring offensive policies, strategies and procedures. One of the first

steps towards TQC would thus be to place responsibility for quality in the hands of the production departments and remove it from the QC department. The question that arises now is, what is the role, if any, of the QC department?

Japanese companies all use the QC department as a facilitator. The function of the much smaller QC department now is to promote the removal of the causes of defects, keeping track of quality accomplishments, auditing quality related procedures, coordinating quality training, and joining buyers in monitoring supplier plant procedures. The QC department might be required to perform certain speciality tests such as chemical analysis, destructive tests or operate expensive testing equipment. They will no longer inspect selected parts, but might be involved in final acceptance testing before finished products are despatched, especially where assembled products can only be tested after assembly.

Finally QC should be involved in receiving inspection, i.e. inspecting the quality of goods coming from other plants. In Japan this type of inspection has mostly fallen away as supplier certification has become so extensive that parts now go directly from the docks to production. (As specified by the JIT system) In Western companies this is not the case and QC should be employed to do incoming inspection.

3.3 Training for TQC

It is obvious that if workers work according to properly specified instructions, rejects would be minimised. The first step in preventing rejects would thus be to train workers to work correctly. This process could be broken down into three steps:

- i. Prepare job instructions which specify the work method.
- ii. Make the details completely understood by the workers.
- iii. Have the workers carefully observe the instructions.

It is suggested that, where possible, workers should be involved when job instructions are prepared. This has the advantage of making full use of the workers' knowledge of the job and getting their cooperation in observing the instructions since they consider it to be their own.

3.4 Motivating for TQC

Total Worker Involvement(TWI), or a motivated workforce, is one of the four building blocks of World Class Manufacturing and is discussed in detail in chapter 4. Three important points in connection with worker motivation towards quality need to be discussed in this chapter:

- i. Traditional management theory has taught us all that it is the function of the QC department to ensure that products produced are

of high quality. TQC theory states that is the responsibility of every individual never to pass on a known defect. Thus we move from inspecting quality into a product to building quality into it. It now becomes each persons responsibility to produce his own quality. This requires a drastic change in attitudes. (Sandras, 1986)

ii. In order to obtain this change in attitude all of management, and especially line supervisors, need to have a passion for quality. They should be seen not just to talk quality, but to live and work quality. This in itself is one of the most important requisites for motivating workers for quality.

iii. An informed worker is a motivated worker. In order to be a quality performer, a worker must know:

- "What must I do?" (objective)
- "How must I do it?" (method)
- "How well must I do it?" (standards)
- "How am I doing?" (results)

3.5 Easy-to-see Quality

Easy-to-see quality is an extension of the above principles, namely that a worker must have measurable standards of quality and receive regular feedback on his performance. Japanese manufacturers have taken this a few steps further. Their plants abound with displays which tell the workers, management, customers and visitors what

quality factors are measured, how they are measured, what the recent performance is, what the current quality improvement projects are, who has won awards for quality, and so forth. All of this is done in simple, easy to understand ways that can be easily understood by the least knowledgeable person.

As it takes time and money to make quality visible, the question arises about what the advantages of easy-to-see quality are.

The first obvious advantage is an increased awareness of quality by the workforce. Workers become more motivated towards producing quality products as their efforts are recognised and displayed in the factory.

The second advantage becomes more apparent when JIT and TQC are being practised by your clients. In order to ensure that they receive quality products from your factory, they will want to visit your factory to make sure that you are in fact a TQC factory. They will demand visual, obvious indicators of quality at every process and the indicators must be easy to understand. Even if your client is not a JIT/TQC practitioner, he will be impressed by your dedication to quality and it could be the deciding factor in the allocation of contracts.

3.6 Analytical Tools

Analytical tools for the solving of problems related to quality were

introduced to Japan by Deming and Juran in the 1950's. Whereas most QC personnel and engineers in Western companies know about these tools and occasionally make use of them, all the foremen and workers in Japanese companies are trained in the use of these tools and make active use of them.

These tools are flowcharts, control charts, cause-and-effect diagrams, histograms, check sheets, Pareto charts and scatter diagrams. They are simple and easy to use and provide enough information to solve any quality problem.

3.7 100% Inspection

In order to produce products free of defects, it is important that all items are inspected during all the stages of the production process and not just sample inspected at the end of the process. Detecting defects during the process has two advantages. Immediate action can be taken to correct the problem causing the defect and thus prevent further defects from occurring. Secondly the defective article can be removed from the process and thus save unnecessary work from being performed on it. In the traditional QA field this 100% inspection would require too many inspectors to be either practical or economical. With TQC, every worker becomes an inspector.

Sequential Checking, Self Inspection, Foolproofing and Line Stop are the techniques that are used to make this possible.

3.7.1 Sequential Checking

In this technique, parts produced by the first operator are immediately passed on to the second operator in the production line. This operator then inspects the part before commencing with his operation on it. If it is defective he cannot continue and, since this prevents him from completing his quota for the day, he immediately informs the previous operator of the problem. The first operator then reacts as expected and tries to eliminate the problem that caused the defective part.

This is in direct contrast to the traditional Western way where parts are produced in large batches. The second worker would not care if he found a defective part. He would simply throw it into a scrap bin and use the next part. He would see no reason to inform the first worker since this reject would not affect his performance.

This technique has the following advantages:

- Immediate feedback is given to the operator.
- It is an inexpensive form of inspection, especially where the operator can inspect the part while waiting for his machine to finish its cycle.
- It assists in developing a team spirit in the workplace. Operators should be encouraged not just to show each other the defects, but also to assist one another in solving the reasons for these problems.
- Reinforcement of the JIT principle which states that products

should be made in as small as possible batches. (In this case a batch of size 1)

It is suggested that workers be swopped around so that they can all experience the same problems and so help each other.

This technique unfortunately has the disadvantage that petty squabbles amongst workers can influence their judgement and cause products to be rejected unnecessarily. It is thus important that inspection standards are clearly defined and all workers know and understand them.

3.7.2 Self Inspection

Self inspection implies that the worker inspects his own work after completion. This method is only to be used where sequential inspection is not possible and where definite standards are available on what is acceptable or not. It is suggested that simple inspection tools such as GO/NOGO gauges are made available to assist the operator in his inspection. Where possible use must be made of foolproofing techniques.

3.7.3 Foolproofing

Foolproofing as a method of self inspection was developed and used with great success in Japanese industry. In this technique mechanical or electrical devices prevent an operator from making or

passing on a defective article. Foolproofing is an extremely powerful tool and is considered to be the main technique used by mass producers in Japan to achieve TQC.

Foolproofing devices could either be of the regulating or warning type. A regulating device would stop the process and the supervisor would have to be called to restart it. The supervisor and worker would then have to find and correct the cause of the defective part. The warning type would not stop the process, but would alert the worker and supervisor of a problem by means of lights or hooters.

As it is possible to ignore a warning signal and carry on producing, it is suggested that, where possible, preference should be given to the installation of regulating instead of warning devices.

There are three basic types of foolproofing mechanisms, namely:

- The contact type which checks variation in shape or dimension by a contact mode of detection. Devices that could be used would include limitsensors, electric probes, light beams, and ultrasonic or inductive sensors.
- The constant number type which confirms whether or not a constant number of parts are present in a product. This could be done with counters, electronic sensors or loadcells.
- The step type which checks if all the steps are followed exactly

as specified.

It must be noted that the Japanese object against the use of the word "foolproofing" as this creates a negative image of the worker. Instead they recommend that the term "mistake proofing" be used.

3.7.4 Line Stop

Line Stop implies that every worker has the right to stop the line if a defect is noticed. A light signal will then alert the supervisor that production has stopped and also shows him which worker stopped the line. Production would only proceed once the worker and the supervisor are both satisfied that the problem has been corrected. Use of this technique reaffirms the TQC principal that quality is the most important production objective, and that it takes preference above production output.

3.8 Housekeeping

Good housekeeping is vital to the success of any JIT/TQC programme. Good housekeeping habits provide an environment conducive to improved work habits, quality and care of facilities. Since housekeeping contributes to quality, it should be the responsibility of the production employees. Workers should be encouraged to keep their own workplaces clean and tidy. One of the JIT principles is that workers should be flexible. Workers who are not needed temporarily, should be used to clean areas of the plant that need

attention.

3.9 Daily routine maintenance

It is obvious that faulty machines would produce rejects. Western manufacturers generally give their machines hard use and over rely on the maintenance department. Japanese production workers in turn pamper their machines. Before starting a machine when going on shift, the worker will follow a checklist and ensure that all important machine functions are operating correctly. Oiling, adjusting, tightening, sharpening, and so on would precede the start of work. This principle is discussed in more detail in the chapter on Total Productive Maintenance.

3.10 Less Than Full Capacity Scheduling

Less than full capacity scheduling is required to allow the worker to make use of the Line Stop and Daily Routine Maintenance techniques. It assures that the daily schedule is met, while time is allowed to maintain the machines and stop the line to prevent defective parts from being produced. Workers are not pressurised and equipment not overtaxed, thus preventing errors that could arise from haste. As line stops due to errors and breakdowns are sure to decrease, total efficiency of the process will increase.

Error prevention also smooths the output rate, which makes it easier to operate without large inventory buffers between processes: the

JIT ideal.

3.11 Project by Project Improvement

In order to ensure that quality improvement is a continuous activity, Japanese companies tackle quality problems as projects. Signboards in Japanese factories will show visitors which projects have been completed, which are in process and who the project team is. It is a source of pride for a Japanese worker to belong to a team which has successfully completed a project. Factories often compete with each other to see who can complete the largest number of projects per year.

Each company has a committee to review proposed projects. Projects are evaluated to determine which would have the greatest advantage. The best are selected and assigned to project teams.

It would often happen that a group of workers in a certain section would decide jointly to nominate a project. They would then form a Quality Control Circle to solve the problem. Two important points should be noted about QC Circles.

- QC Circles are not the quick-fix to quality problems that Western companies expect them to be. QC circles are only one of the many techniques available to help solve quality problems. If QC Circles are established with the expectation of being the company's quality control salvation, disappointment will surely result.

- Circles are completely voluntary and should be initiated by the workers themselves. That is not to say that management may not advertise the concept, it just states that workers should want to start a circle themselves when a problem prevents them from reaching their goal.

CHAPTER 4

Total Worker Involvement

Total Worker Involvement (TWI), together with Total Quality Control, Just in Time and Total Productive Maintenance, are the four building blocks of World Class Manufacturing. World Class Manufacturers expect their workers to be inspired, motivated and totally involved in the business of the company. Workers must be completely loyal towards the company and have the company's success as their major aim in life. In return the company offers the worker guaranteed employment, above average salaries and participation in the management of day to day activities.

This ideal situation exists in major Japanese companies, but most South African managers are doubtful whether it can be achieved in South Africa. The major obstacle which prevents us from achieving TWC in our companies, seems to be the nature of our third world work force. A notable exception was the successes achieved by Cashbuild in motivating their workers to rise above political ideas. (See section 4.5.1) Although their success was only temporary, it proved that South African workers can be totally involved.

The aim of this chapter is to give South African managers background information on what is required to obtain Total Worker Involvement. The first section describes the importance of TWI and its relationship to the other elements which make up World Class

Manufacturing. Section 4.2 explains why the Japanese worker is the ideal totally involved worker. Section 4.3 describes the South African workforce and in particular the Black worker and his attitude towards life, work and politics. In Section 4.4 the South African worker is compared to the Japanese worker in order to see whether the same level of commitment can be obtained from him. The chapter is concluded with some suggested techniques for improving worker involvement in South Africa.

4.1 Total Worker Involvement and World Class Manufacturing

All managers would like their workers to be totally involved and committed towards their company. The advantages are obvious. They would work harder, complain less, make fewer rejects and be prepared to earn less. Unfortunately these selfish reasons are often the reason why workers are not involved. Management is perceived as an exploiter of labour, with the result that workers rebel against company efforts to get them involved.

Worker involvement should be sought in order to create an environment which is conducive to problem solving and efficiency. This improved efficiency of the company should hold advantages for the worker. Not only must he be able to get more satisfaction from his daily work, but he must also be able to see the difference in his standard of living.

World Class Manufacturing requires workers to be totally involved.

Workers are to be flexible, responsible, innovative and committed in order for WCM to be successful. This is in complete contrast to how South African managers presently see their workers. It is the author's opinion that the degree to which South African managers can involve their workers, will determine whether or not WCM can be successfully implemented.

4.1.1 TWI and Just-in-Time

JIT is a manufacturing management philosophy which aims to produce instantly with minimum inventories. This is achieved by making use of a few revolutionary techniques. These techniques all require worker participation.

In order to instantly change production from one product to the next, setup time reduction is required. This is achieved through reorganising the change procedure and making use of custom designed holding devices. If the workers are negative about the new procedure, they will make sure that it does not work. Their involvement and innovative abilities are also required when designing the custom made equipment.

Traditional manufacturing techniques as taught in the West, require workers to become skilled in only one particular job. JIT requires multifunction workers who can do more than one job and who can move from one position in the plant to another at short notice. Workers who are not committed to the success of the company often rebel

against sudden job changes.

4.1.2 TWI and TQC

TQC requires workers to have pride in the quality of their work. Workers are trained not only to manufacture, but also to inspect. TQC requires workers to participate in the solving of quality related problems. All of this can only be achieved with an inspired workforce.

4.1.3 TWI and TPM

The basis of TPM revolves around the theory that maintenance personnel alone cannot maintain machinery adequately. They require the active cooperation of production workers. Production workers are trained to inspect and service their machinery on a daily basis and report any emerging defects immediately. As production workers see this as an extra burden, they will only co-operate if they are totally involved and motivated.

4.2 The Japanese worker and his commitment towards his company

Japanese companies, and their successes, are often quoted as examples in WCM case studies. South African managers often feel that similar successes are not possible here due to the differences in workforces. The Japanese worker is seen as efficient, hardworking, thrifty, very tidy and highly motivated and loyal.

This is partly true.

The Japanese as a nation are generally thrifty, hard working, honest, humble and have a craving for education. These traditional characteristics have been forced on to them by the relatively small size of their country and the close proximity in which they have to live with each other. The Buddhist religion, and specifically Zen Buddhism, has also assisted in moulding the national character this way. (Smith, 1981)

The second reason for the success that the Japanese companies have in motivating their workers, is the management style that is used. It often surprises visitors to hear that management styles developed in the West are used more successfully in Japan.

It would thus be fruitful to examine the Japanese worker and his commitment towards his company in some detail. To start, it must be noted that not all Japanese workers are employed under the same conditions. Three different groups of workers can be identified, namely male workers permanently employed by large industrial organisations, male workers employed by smaller companies and women.

4.2.1 Male workers employed by large industrial institutions

The large industrial institutions are the backbone of the Japanese industry. They are small in number and mainly produce mass consumer durables for the local and international market. They are often

household names in Japan and the West. Examples would include Toyota, Nissan and Honda (vehicles), Sony, Matsushita (TV and sound equipment), New Japan Iron and Steel, Mitsubishi etc. Their factories are large, capital intensive and very efficient. This has the result that although they produce most of Japan's income, they only supply work to 10 - 15% of the country's workforce. (Smith, 1981)

As these are the companies that have achieved considerable success in WCM, it would be appropriate to study their strategies with regard to Human Resources Management in some detail.

(i) Lifetime employment - A worker joins the organisation after full time education and spends his whole working life there. His loyalty to the company is expressed in a willingness not to seek other employment and to serve the company in any capacity in whatever part of Japan is required. In return the company offers him virtual security of employment and a variety of other benefits. These include salary rises according to his needs, commitment increases, retirement benefits, health care, company housing, membership of sports clubs etc.

(ii) Harmony - The Japanese put a very high value on harmony in human relations, and regard conflict as something to be avoided whenever possible. Both workers and management would go out of their way in order not to disturb the harmony in their relationship with each other.

Acceptance time is often built into the planning of efforts to influence workers. Issues are never forced on to workers. Workers are informed of any impending changes and then given time to consider them. The Japanese believe this is partly responsible for their success in maintaining a healthy Industrial Relations atmosphere.

(iii) Needs - Company management see each individual as having economic, social, psychological and spiritual needs. Japanese executives assume it is their task to attend to many of the needs of the "whole" person, and not leave other institutions (such as government, family or religious ones) to fulfil them. They believe it is only when the individual's needs are well met within the subculture of a corporation, that he can be largely freed for productive work. This is achieved by making use of the Japanese tendency to form groups.

(iv) Groups - In his day to day life the worker is a member of a small group, made up of workers in the same office or workshop. It is through his membership of this group, the sense of identification and loyalty to his group, that his loyalty to the larger group is expressed. Almost all of his free time -- and his leisure is spent with this group. A worker would sacrifice his Sunday at home with his family if company business or social activities with colleagues require it.

This group is seen as an extension of the family farming village

which existed in pre-war Japan. This village was run on a communal basis with the father being in charge. It is a traditional situation and the modern Japanese worker adapts to it easily. In the work group the supervisor assumes the father-role and not only supervises work, but also assists the worker in personal matters. It is not uncommon for a supervisor's opinion to be sought in such matters as choosing a wife.

Management, in turn, discourages individual performance as this breaks the harmony in the group. Individuals are seldom given recognition for performance. Instead the group will be praised and rewarded for an achievement.

Workers often go out of their way to prove their loyalty to the company, by not taking leave or starting early and working late. A large majority of workers state that the success of the company is their major source of satisfaction in life.

(v) Spiritual values - It has been mentioned earlier that Japanese companies believe in also satisfying the spiritual needs of their workers. This is done by making sure that all the activities of the company comply with the values it professes. These values are often formally stated and taught to workers. In the large Matsushita company (87 000 workers) for example, all the workers get together in their respective workplaces at 8:00 am. They then sing the company song, recite the code of values and listen to a 5 minute lecture by one of their fellow workers. In this talk he will

explain how one of the values can be applied in their day to day work.

The code of values for Matsushita are listed below:

BASIC BUSINESS PRINCIPLES

To recognise our responsibilities as industrialists, to foster progress, to promote the general welfare of society, and to devote ourselves to the further development of world culture.

EMPLOYEES CREED

Progress and development can be realized only through the combined efforts and cooperation of each member of our Company. Each of us, therefore, shall keep this idea constantly in mind as we devote ourselves to the continuous improvement of our Company.

THE SEVEN SPIRITUAL VALUES

- 1) National Service Through Industry
- 2) Fairness
- 3) Harmony and Cooperation
- 4) Struggle for Betterment
- 5) Courtesy and Humility
- 6) Adjustment and Assimilation
- 7) Gratitude

(Pascale and Athos, 1983)

These values, taken to heart, provide a spiritual fabric of great strength. They appeal strongly to Buddhists, Christians, even atheists and to the Japanese in particular. They foster consistent expectations among employees in all the various plants around the world. There is agreed opinion amongst the workers of this company that this is one of the major reasons for their company's success.

(vi) Trade unions - Workers in this group all belong to company unions i.e. unions with members from one company only. These unions are often hampered in their bargaining role by the attitudes of their members. The workers consider their wellbeing depending on the success of the company and would thus not go on strike or accept higher wages if they feel it would harm the company. The unions however achieve limited success in creating better working conditions for workers.

4.2.2 Male workers in small companies

Well over two-thirds of the Japanese labour force are employed by firms with less than 500 workers. These firms are often under-capitalised, inefficient and work to lower profit margins than their larger counterparts. They are thus unable to emulate them in terms of benefits to employees. Housing is the exception rather than the rule, and very few firms can afford medical insurance or pension schemes for their workers.

The most crucial difference is that the smaller firms are far more

exposed to variation in the economic climate than are large concerns and, therefore, cannot offer the security of lifetime employment which is the keystone of the system described earlier. Bankruptcies are common and labour turnover high. Two factors seem to compensate to some extent for the fact that the small business cannot offer a great deal of security.

The first is that the smallness of the firm enables it to be more of a "family enterprise". Although the workers may not be related to each other, the owner will take on a father-like role and the workers would respond as children. The employee can thus identify with the firm itself on a personal level. The employment relationship is more of a genuine extension of the family-like relationship which existed in the farming village, and less of a conscious attempt to imitate it. The same group loyalty with resultant advantages thus develops as in the larger concerns.

The second is that labour has always been in short supply in Japan during the past three decades. Even if a worker had to lose his job in a certain sector of the industry, he is bound to find work within a few weeks in another sector. Workers thus do not see the inequalities of the system as being particularly unjust.

4.2.3 Female workers

Female workers also have little place in the lifetime-employment system. Despite the guarantees of equality in the post-war Japanese

Constitution, women are discriminated against in all areas of employment. Most female workers will never rise above low-grade clerical or assembly work. Except in a few professions, it is virtually a condition of employment that a female white-collar worker must resign on marriage.

The female worker does have two advantages in the job market, namely the low wages at which she is prepared to work and her "sackability", which makes her an ideal worker to employ in a recession period. Thus, women are used to a great extent in assembly lines where little training is required.

4.3 The black South African worker and his commitment towards his company

South Africa is a heterogeneous country made up of various cultural groups. Twelve major cultural groups can be identified of which nine are black. The remaining three groups, namely the Whites, Coloureds, and Asians can be classified as "Western", while the Blacks must still be considered as "Third World". It was thus decided to study the black worker and his commitment towards his company in some detail.

Black people make up 68,8% of the total South African population and can be divided into nine main tribes, namely Xhosa (5,6 million), Zulu (5,2 million), North Sotho (2,6 million), South Sotho (1,6 million), Tswana (2,7 million), Shangaan-Tsonga (1,0 million), Swazi

(841 000), South Ndebele (378 000) and Venda (476 000). (Bureau for Information , 1990) The cultural background of these groups may differ, but their basic attitudes towards work, politics and their employers are the same.

4.3.1 Black culture

Well over half of all Blacks still cherish values which maintain some of the customs and practices of their traditional society, with an emphasis on social organisation based on kinship and social grouping. It would be important to any manager who wishes to inspire black workers, to take note of these customs and practices as this often explains Black workers' non-Western behaviour in the work situation.

Marriage is an important institution, and is the only acknowledged means by which adulthood is conferred upon the individual. All groups prescribe certain preconditions for marriage. All insist on formal acknowledgement of physical maturity as males or females and all require the payment of marriage goods by the father of the male to the bride's father. These goods are to compensate the father for the loss of his daughter. It is also the duty of the fathers to arrange marriage partners for their children.

Apart from bestowing adulthood, marriage converts unrelated people first to affinal kin (relatives by marriage) and then, one generation downward, into blood relatives. This has the effect of

drawing together unrelated people in a network of relationships which are partly political, partly economical, partly religious- and well defined in customary law. E.g. all of one's mother's sisters would be classified as mothers, and brothers need not have the same father or mother, as long as they are related.

Traditional religion can be described as an ancestor cult. Its values support kinship bonds and marriage ties. A man's salvation may, in fact, be closely related to his ability to marry successively and increase his number of children. By this means, he ensures the continuation of his lineage as well as its enlargement. After death, he is venerated as ancestor by all of those linearly related to him. For them, he is a link with the unseen world and will intervene on their behalf in times of need.

The traditional economic system is based on a subsistence rather than a profit philosophy. The concept of overproduction in specialist fields for distribution by marketing is foreign to traditionalist Black society. Subsistence economics implies self sufficiency of economic units, so that each household provides for its own needs. A man with three wives would thus occupy more land than a man with only one wife.

Nowhere is subsistence-based thinking so obvious as in traditional African conceptions of time. The Black man considers time as a commodity, just like the Westerner, but uses as much or as little as is required. The notion of deadlines to be met, and therefore haste

or urgency, is foreign to traditional society.

A straightforward division of labour between men and women confines the latter to working in the fields and household tasks, while men take charge of animal husbandry as well as administrative tasks. Established social sanctions make it ridiculous for men and women to share the same task. Seniority also affects economic behaviour. Thus, the motivational structure of traditional Black society depends to a large extent on the system of rights, duties, privileges and obligations imposed upon it by the network of interpersonal relations. These are often in conflict with the contractual requirements of the general labour market and give rise to many problems and misunderstandings between White and Black in the factory.

The gradual urbanisation and Westernisation of the Black community is gradually blurring the differences between traditional Black culture and Western culture, but it is expected to be a problem in industry for many years to come. Managers wishing to convert to WCM would be wise to take note of this and to tread carefully when implementing changes.

4.3.2 Black Development in Labour and Politics

Black workers, through their trade unions, often act in a seemingly militant way. The manager wishing to make use of WCM techniques, might often come into conflict with these groups and find their

attitudes very negative and illogical. An insight into the history of Black politics and trade unions, might explain some of these attitudes. It could also assist the manager in dealing with the situation.

Racial division of the industrial workforce has been practised in South Africa since the arrival of the first European settlers in 1652, when extensive use was made of slave labour. Slavery became an integral part of the Cape Colony and the Boer farmers carried these ideas into the interior. Blacks were expected to perform manual labour in return for squatting rights.

With the discovery of gold and diamonds, a need arose for skilled as well as unskilled labour. Skilled labour was imported from Europe and Australia at great cost. At first there were sufficient unskilled Black farmers willing to work in the mines for short periods, but as the demand grew, a shortage of unskilled workers arose.

The mine owners had tremendous influence over the government, with the result that laws were passed to facilitate the creation of a cheap pool of labour. These laws required Black subsistence farmers to pay a hut and poll tax. Blacks were thus forced to go work on the mines in order to pay their taxes. When this did not have the required result, the Land Act was passed.(1913) The Act reserved approximately ten percent of South Africa for Black ownership and stopped Black farmers from renting land from White farmers. The Act

thus forced many squatters into towns to look for work.

The pass law compelled Blacks to look for jobs in specific districts where employers most wanted labour. They were forced to take any job offered as the pass law only permitted them a few days in which to look for work. The Chamber of Mines further agreed upon a low maximum wage to be paid to Black workers. Further controls over Black workers were implemented by means of the compound system which ensured amongst other things, a social division between the white and Black workers. Black workers could not obtain passes for their wives and children, and had to leave them behind in the rural areas.

As Black workers became more skilled, and previously skilled jobs were simplified, more and more Blacks aspired to fill positions previously held by Whites. White workers felt threatened by this and it led to a series of strikes between 1897 and 1922. As a result, the Government passed the Mines and Works Act which set aside 32 job types for White workers in 1911. Further industrial action by White workers led to the fall of the Smuts government in 1924. This eventually led to the election of the Nationalist Party in 1948.

During this early period on the mines, the Black workers' power, in contrast to the Whites, was limited. Strikes were easily defeated as the compounds were well controlled by the police. Black workers did not organise into trade unions due to the compound system which isolated the groups from each other. In addition tribal allegiances

were still very strong and prevented the formation of trade unions.

In 1924 the South African Communist Party initiated the appearance of several Black Unions. By 1945 the Council for Non-European Trade Unions (CNETU) claimed to represent 158 000 members in 119 unions. In 1950 the Nationalist government passed the Suppression of Communism Act. Large numbers of trade union leaders were banned or arrested. Political organisations such as the ANC and PAC, which had supported many of the unions, were banned. The result was that total Black union membership fell to 64 000 in 1961.

After the Sharpeville incident, banning orders were served on virtually all Black trade union leaders. Consequently, Black trade union activity virtually disappeared during the 1960's. Government and employer controls ensured a period of industrial peace, which was deceptively calm.

In 1973, widespread strikes by Black workers over wages, brought industry in Natal and the Transvaal to a virtual standstill. No trade unions were involved, and this caused many problems as employers were unable to identify with whom they could negotiate. The government acted swiftly and passed the Bantu Labour Relations Act, which provided for the settling of disputes by means of a works or a liason committee within a company. This system soon proved ineffective as works committees had no bargaining power. More and more employers began bypassing the formal system and bargained with unregistered unions.

The Wiehahn Commission was established to attend to these problems and in 1979 its first report was submitted. It was generally well received and its major recommendations were that freedom of association should be granted to all workers irrespective of race and status. Unions were also to be given full autonomy in deciding membership criteria. Job reservation was to be abolished.

In August 1981 the Labour Relations Act was passed to address these recommendations. Unfortunately, the reforms were not consistent with political, economic and social divisions in the wider society, and thus conflict continued to escalate as found in the present day situation.

In 1988 the Pass Laws and influx control were scrapped with the result that urbanisation of the Black community increased drastically. This created large pools of unemployed workers in the major industrial centres. Many of these workers live in squatter conditions due to a shortage of suitable housing. Radical organisations made use of these conditions to organise action to disrupt industries. This was done to force government and business to recognise their struggle. The result was a series of work-stoppages, stay-aways and strikes organised mainly by the trade unions.

In February of 1990 the Suppression of Communism Act was repealed and the banning of various organisations and individuals was lifted. These included the African National Congress, the South African

Communist Party and all of their officials. Government immediately began negotiating with these parties in order to find a solution to the country's political problems. This also had an effect in industry. Workers' expectations were heightened and many of them expected immediate improvement in their situations. Previously banned organisations could now organise freely, and this led to increased civic action with resultant damage to industry.

4.3.3 Trade Unions in South Africa

Finnemore and Van der Merwe (1987) see three different approaches to trade unions in South Africa:

(i) Unitarism - This approach is found amongst a small section of the work force, mainly of the older generation, and is frequently supported by employers. It assumes that the organisation is a unitary structure, and that employers and workers have the same objectives and values. A trade union is seen as promoting distrust between employers and workers and should be avoided. Conflict is caused by agitators and is not inherent in the relationship. The "boss" role is paramount and legitimate. It assumes that workers are satisfied in what may often be seen as a paternalistic situation.

This strongly reminds one of the Japanese attitude towards work and trade unions.

(ii) Pluralism - In this approach the organisation is seen as comprising of individuals and groups who have conflicting interests and goals. A trade union is a legitimate means by which workers may protect and further their interest. Conflict is natural and unavoidable but should be non- destructive. Collective bargaining is the means by which compromise is achieved, but should be done according to a set of agreed rules. All parties should be committed to the system. Management's role is accepted, but the workers must be involved in certain areas of decision making.

All the parties are seen to benefit from this approach and it is thus the most popular viewpoint of the larger, progressive organisations. It is also the approach favoured by a large percentage of workers in South Africa. Unfortunately, it is not possible to determine what percentage of workers and labour leaders favour this approach over the following one.

(iii) Radicalism - This approach is based on Marxist theory and argues that the organisation is a reflection of the greater society in South Africa. Society consists of two classes, namely the owners of property (capitalists) and the property-less (labour). Conflict is endemic. Capitalists are all-powerful and extract the maximum surplus value from production by labour. Labour has insufficient resources to prevent this process of exploitation and demands its share of the national product. Collective bargaining is an employer strategy whereby the trade union is co-opted into the capitalistic system. A trade union is not merely an industrial phenomenon but

must be part of the working class challenge. There is no element of mutual survival which binds the classes. Capitalists are committed to serve only their own interests, and labour must therefore replace the system with one of worker control of state and industry.

This approach is favoured by the younger Black worker who is not prepared to accept the poverty of his community. He has seen the unfairness of the Pass Laws which virtually destroyed Black family life and he refuses to work under the same dehumanising conditions that his father did. It is also the only approach which strives to give him political power.

4.3.4 Black needs and commitment

Satisfying the needs of a worker is the first step in getting his commitment. Different people and organisations have different ideas of what the needs of the black worker are.

In 1972 the Inter-African Labour Institute listed the following points as prerequisites for securing the maximum productivity from Black labour: (Horner AJ, 1972)

- (a) Adequate financial reward must be set.
- (b) The task to be performed must be of such a nature that the worker can take pride in his work.
- (c) The worker must be instructed in the correct method of performing the task so that he feels he is doing a good job.

- (d) The worker must possess the aptitude and intelligence necessary to perform the task correctly.
- (e) The worker and his dependants must be suitably and comfortably accommodated.
- (f) The worker must be able to obtain adequate, nutritious food.
- (g) Management must be good and the workers must feel it to be so.

This has a ring of unitarism to it and differs significantly from the present day stand-point of the Congress of South African Trade Unions (COSATU): (Levy, 1990)

Workers (and their trade unions) should be involved in the "mass struggle". Only when the struggle against exploitation and apartheid is over, will the workers' needs be met.

4.4 The Black South African worker compared to his Japanese counterpart

Sections 4.2 and 4.3 might give the reader the opinion that the Black worker is not suited to work in a WCM environment. This opinion could be formed if only the differences between Japanese and Black workers are considered. Fortunately major similarities also exist between these groups. These similarities should be investigated and used to prepare the Black worker for WCM.

4.4.1 Lifetime employment

Due to an excess of unskilled labour, a shortage of work exists for most Black workers. This has the result that very few Black workers ever feel the need to resign and look for work elsewhere. Lifetime employment has thus become a natural way for most Black workers.

Unfortunately labour is relatively cheap in South Africa and managements have become used to hiring and firing as the market demand rises and falls. The result of this has been that many workers do not feel that their jobs are secure. They therefore see no reason to help the company achieve its goals.

The notion also exists that productivity increase would cost people their jobs as fewer people are required to do the same work.

If lifetime employment was guaranteed to workers, it would be easier to convince them that their personal situation is dependant on the success of the company. They would then be prepared to assist in productivity and problem solving exercises. (Section 2.2.8 explains how WCM companies adapt to fluctuating demand while offering lifetime employment.)

4.4.2 Groups

Black custom places heavy emphasis on the formation of groups. In the traditional village this group consists of all of the related

households. As explained earlier, marriage between members of separate groups causes the groups to combine, thus resulting in a village with one group identity. In this group the individual is protected from external influences, thus keeping him safe and protecting his traditions.

The urbanised Black worker has adapted this group identity to his work situation, with the result that workers in a particular factory often form a very strong group. This group identity is often demonstrated when unions organise industrial action such as strikes, stay-aways, or go-slows. Management thus tends to view this group identity in a negative light and often attempts to break the group. These attempts usually fail and lead to violence and disruption.

This group identity should be used to the company's advantage, as done by Japanese companies. Attempts should be made to build team spirit, by organising sporting events. The group should be praised or disciplined when performance is either good or bad. Where possible individuals should not be singled out for praise or discipline.

When the group identity is used correctly, there will be no need for motivating or disciplining specific individuals. The other members of the group will correct his behaviour. All that needs to be done is to motivate the group to accept the company values and objectives.

4.4.3 Harmony

Black people, like the Japanese, place heavy emphasis on social harmony. They do not like to be in confrontation with management or members of their group. This is contrary to Western norms where children are taught to be aggressive in work and business. This feature should be recognised and used by managements to create a pleasant and productive environment. As soon as the harmony is disrupted within an organisation, productivity will fall and vice versa.

4.5 Suggested techniques for improving worker commitment in South Africa

4.5.1 Participative Management

Participative management has been a buzz-word in industry for many years, but until Cashbuild, had never been truly implemented in a South African company. Participative Management is a management philosophy which simply states that all employees should participate in all levels of management of the company. It requires careful planning and protracted negotiations to implement. It can also go through various formats until a system which satisfies most of the company employees is implemented. It is a hard and difficult road to follow, and certain members of management will not be able to accept this form of power sharing and leave the company, but the Cashbuild example proves that it is worth the effort. (Koopman, 1987)

Cashbuild was started in 1978 as a chain of wholesale builders' merchant stores. Initially it was very successful and by 1982 it consisted of 12 stores generating a pre-tax profit of close to R700 000. In 1982 profits started decreasing and the Managing Director, Albert Koopman, decided to investigate the problem. He found that drastic changes were required in the company's philosophy, culture and management style.

A program of participative management was started and by 1986 full worker participation had become a reality. The result was an increase in company profits to R1,6 million in 1984, R4 million in 1986 and R5,2 million before tax in 1987.

4.5.2 Suggestion schemes

Suggestion schemes had been used in Western industries since the 1930's when the Scanlon plan was developed. They all depend on workers to put forward suggestions of possible changes that would improve productivity. A committee then investigates the proposal, implements it if feasible and determines an appropriate financial reward for the worker.

On the surface, the idea sounds perfect and it has been implemented by most companies in South Africa and in the West. Unfortunately few of these schemes have achieved noticeable results, both in improving productivity or worker involvement and most have faded away after a few years. In South Africa, ISCOR led the way with its

PIP (Productivity Improvement Program) system and claimed huge savings, yet it was cancelled in 1987.

Japanese suggestion schemes, in contrast, have no monetary incentive, yet are extremely popular. Toyota, for example, receives millions of suggestions each year with an acceptance rate of 90%. (Suzaki, 1987)

The first problem with Western style suggestion schemes seems to be the monetary incentive. Before a suggestion is accepted, it must be proven to be financially viable. Japanese managers, in contrast, will implement any project, as long as it improves the work situation. It does not have to save the company money.

The monetary incentive also has a second disadvantage in that workers feel cheated if their suggestions are not accepted. Rumours abound in such organisations of managers who have stolen workers' suggestions and claimed they were their own. Such misuses of the system have either led to the cancellation of the scheme or over-complicated administrative procedures.

It is thus suggested that suggestion schemes be operated in the Japanese way. No financial incentive is set and accepted suggestions are implemented immediately. Workers are given recognition by having their photo displayed on the notice board or in the in-house magazine. Seeing his suggestion implemented is normally enough motivation for a worker to look for new ways to

improve his job, thus being involved in the management of his work.

It is important to remember that the group identity should not be harmed by this praise of an individual. For example, the caption to a photograph in a newsletter should read: "Mr Ntoni from S28's suggestion has been implemented - WELL DONE S28!" In this manner the group feeling is enhanced.

4.5.3 Incentive schemes

Incentive schemes could offer either a monetary or non-monetary reward. Monetary awards typically include production bonuses and profit-sharing. Non-monetary awards include certificates, newspaper coverage and membership of special clubs.

Once again awards should be made to the group and not individuals. If S28 reaches its target, give a bonus to everybody on the shift.

4.5.4 Training programs

Specialist training programs are available to South African companies who wish to address certain misconceptions or lack of knowledge by their workers on certain subjects.

6M, developed by the NPI, is a program designed to teach the basic business principles to Third World workers. The six M's (Money, machines, manpower, material, market and management) and their

interdependence on each other, are explained by means of scale models to the workforce. The program aims to remove certain misconceptions that workers have about the free-market system. These misconceptions (e.g the boss owns the company and keeps all the profits for himself) often prevent workers from becoming involved in improvement exercises.

The Cross-Cultural program used by Everite, is a program which aims to bring people of various cultural backgrounds together. Classes are mixed and contain members of all of the cultural groups in the organisation. It is a two day workshop in which the facilitator introduces certain topics and then allows the group to discuss them.

Topics would include:

- A definition of culture
- Differences between cultural groups
- The company culture
- The present political scenario
- The role of trade unions
- Hopes and fears of the different groups
- etc

It is hoped that the program will break down the barriers between the various groups so that only one group can be identified in the organisation, namely the company employees.

CHAPTER 5

TOTAL PRODUCTIVE MAINTENANCE

Total Productive Maintenance(TPM) is a management philosophy which aims to reduce production machine downtime, due to breakdowns, to zero. TPM together with Just-in-Time(JIT), Total Quality Control(TQC) and Total Worker Involvement, are the four components of World Class Manufacturing(WCM). World Class Manufacturers require TPM for two very important reasons:

Firstly, JIT manufacturing requires that buffer stocks between processes be eliminated. (See Chapter 2) The result of a breakdown on a factory operating without buffer stocks would be catastrophic. The Kanban system would prevent both up- and downstream workstations from operating, thus bringing an entire line to a standstill. JIT thus requires 100% machine availability.

TPM is also required by Total Quality Control. TQC aims at reducing rejects to zero. (See Chapter 3) One of the techniques employed to achieve this allows any operator to stop the production line, if he notices a machine producing reject products. As TPM will ensure that machines are in perfect condition, no rejects will be produced, thus achieving TQC.

Many of the techniques and principles applied in TPM are used in Preventive Maintenance. TPM is in fact an extension of Preventive

Maintenance, the major differences being:

Preventive Maintenance users assume that there is an optimum availability level at which production machinery should be kept. Any higher would require too expensive maintenance, any lower would result in expensive breakdowns. TPM requires an availability of 100%.

Preventive Maintenance users believe that the maintenance department carries the responsibility for maintenance. With TPM the production department shares the responsibility and actively assists in maintaining machinery.

5.1 Preventive Maintenance

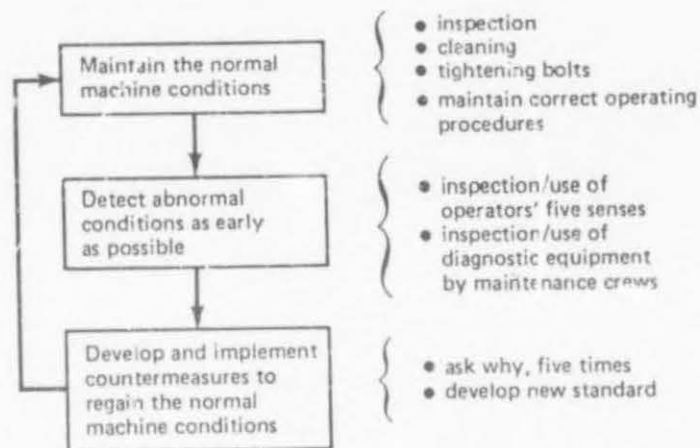
Two basic approaches can be found concerning maintenance of production machinery. The first assumes that machines must be operated until they break. They are then repaired or replaced. This approach, called forced deterioration, is often used on plant and machinery which is difficult to reach or maintain. In these cases a backup piece of machinery is often installed to be used when the original piece of equipment fails.

The second approach to maintenance is called Preventive Maintenance and consists of regular inspections of machinery. During these inspections, wear items are replaced, lubricants checked or replaced, bolts and glands tightened etc. The purpose of Preventive

Maintenance is to prevent the machine from breaking or producing faulty products while in use. Figure 5.1 shows the approach which should be followed to prevent machine breakdown and trouble.

(Suzaki, 1987)

Figure 5.1 PREVENTING MACHINE BREAKDOWNS



5.1.1 Maintain the normal machine conditions

This is the first and most important step in Preventive Maintenance and involves both the operator and maintenance personnel. As the operator is the person who knows a machine the best, he would be the first person to detect any variance in operating condition. He should thus be trained by Maintenance on how to do regular inspections of his machine. These inspections are normally carried out at the start of a shift. Any abnormal conditions should then be reported to the maintenance personnel so that it can be repaired. Maintenance could also train the operator

to do some of the repairs and settings himself. It is suggested that a checksheet be developed to assist the operator in this daily inspection.

During the daily inspection the machine can also be cleaned, oiled, bolts tightened etc. Cleaning is a very important part of daily maintenance as it not only prevents waste from damaging sensitive machine parts, but also exposes hidden defects and contributes to good housekeeping.

Maintaining the correct operating procedure also contributes to longer machine life. Operating a machine at a higher output, speed, temperature or pressure than it was designed for will decrease its useful life considerably. Using the wrong sequence of steps when operating a machine will have the same effect.

5.1.2 Detect abnormal conditions as early as possible.

It has already been mentioned in the previous section that the operator is the person who will detect any abnormal condition first, since he knows the machine best. He should thus be trained to use his five senses to do this and be made aware of the initial symptoms of machine trouble namely noise, vibration, heat, leaks or dirt. The importance of his reporting the problem to maintenance should also be explained to him.

Where possible ways must be defined to measure degree of machine

deterioration. In this way there will be no disagreement between operators on different shifts, or between Maintenance and operator whether or not a machine needs attention or not. Examples would include measuring torque levels on bolts, hardness of surfaces, tension of drive belts or cycle times of equipment. If the correct value is known and preferably displayed at the machine, there can be no disagreements.

Specialist diagnostic equipment can also be used to detect variations in machine condition. Maintenance or even laboratory personnel who have received specialist training usually operate this equipment. Examples would include vibration analysers, ultrasonic or x-ray equipment, oil sample analysers etc.

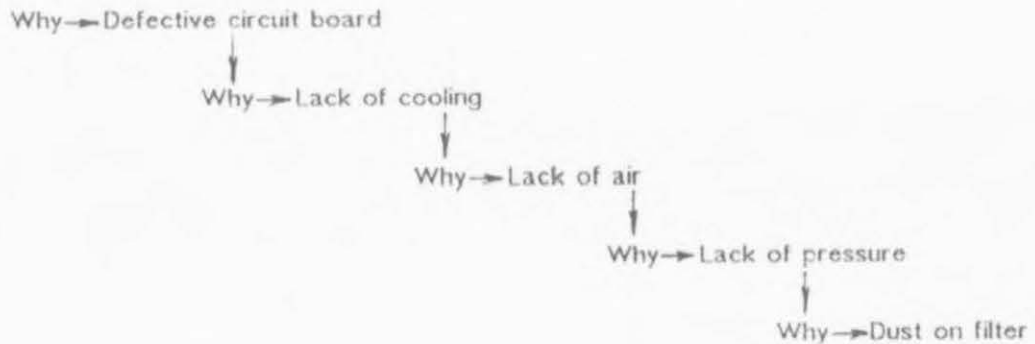
5.1.3 Develop and maintain countermeasures

If an abnormal condition is detected, it needs to be investigated to determine its cause. Once the cause has been identified, countermeasures can be implemented to prevent re-occurrence.

Suzaki(1987) recognises two types of problems that cause abnormal running conditions, namely suddenly exposed and chronic problems. The causes of suddenly exposed problems are usually detected easily, as the relationship between cause and effect is generally clear. The five "why's" technique can also be used to determine the cause of a suddenly exposed problem. This consists of asking "Why?" five times when a problem is investigated.(See figure 5.2)

Figure 5.2 THE FIVE WHY'S

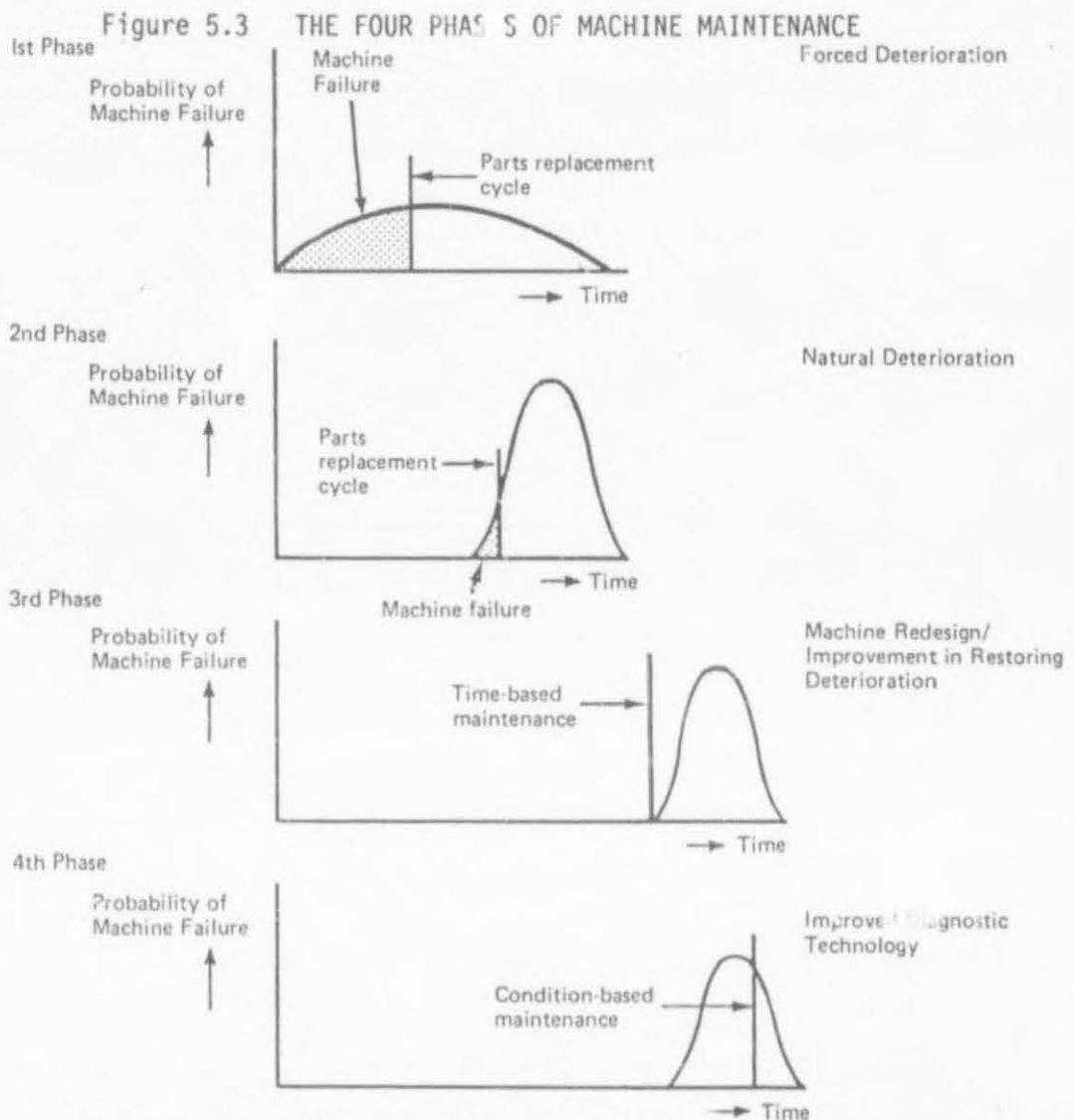
Problem : Malfunction of digital controller.



Chronic problems are generally more difficult to solve, as they usually have more than one possible cause. It is often not possible to determine exactly which possible cause needs to be eliminated. In this case, more than one countermeasure needs to be implemented. It is recommended that an Ishikawa diagram be used to determine all the possible causes of the problem. (Suzaki, 1987)

5.2 The four phases of machine maintenance

A Preventive Maintenance program should be implemented step-by-step in a planned manner. This will prevent unnecessary expenses, as certain improvements only show results if others have already been implemented. E.g. buying and using expensive diagnostic equipment has no effect on machine availability, unless continuous efforts are made to restore machines to their original condition. Figure 5.3 shows the four phases necessary to implement Preventive Maintenance.



In the first phase forced deterioration is taking place, i.e. no routine maintenance is carried out on the machinery. The result is that machinery is operated under conditions for which it was not designed. This would include insufficient lubrication, bolts at incorrect torque, worn bearings, leaking seals etc. This situation is unacceptable. The machines have to be restored to their original level of performance. This would include a thorough cleaning of all machines.

In the second phase only natural deterioration is taking place. Periodic preventive maintenance is performed by the Maintenance Department on machinery in order to assure that it operates under design conditions. Under these conditions machines last much longer. Mean-Time-Between-Failures(MTBF) for most components can be forecasted and the components replaced before breakdowns occur. Unfortunately machine breakdowns still occur due to unexpected component failures. The majority of Western industries are probably in this phase.

In the third phase continuous efforts are being made to keep machinery at the correct operating condition. This is done by training operators to monitor their own machines and make certain repairs and adjustments themselves. Operators, as well as maintenance personnel, receive constant training to ensure that no unnecessary mistakes are made. Foolproofing is also used to prevent these mistakes. Certain machine parts might also be redesigned in order to extend machine life.

In the fourth phase condition-based maintenance takes place. Diagnostic equipment is used to constantly monitor the machine's condition so that timely action can be taken to prevent breakdowns. Maintenance costs are reduced as parts only get replaced when they show signs of rapid deterioration. No unexpected breakdowns should take place as failure of components can now be predicted. (Suzaki, 1987)

5.3 Total Productive Maintenance

TPM aims to have all employees participating in productive maintenance activities. Production personnel should be:

- (i) Trained to do routine housekeeping, oiling, bolt tightening etc., to prevent forced deterioration of machines.
- (ii) Trained in the proper operation of machines.
- (iii) Aware of the importance of detecting early signs of deterioration.

The role of maintenance personnel is to:

- (i) Assist production personnel in self-maintenance activities.
- (ii) Repair and restore deteriorating machinery to operating condition.
- (iii) Improve on machine designs
- (iv) Train operators in maintenance skills.

In summary, it can be said that a close working relationship should be developed between Maintenance and Production before TPM can succeed.

P A R T I I

THE APPLICATION OF SOME WORLD CLASS MANUFACTURING
TECHNIQUES IN THE FIBRE-CEMENT INDUSTRY

CHAPTER 6

THE MANUFACTURING OF FIBRE-CEMENT SHEETS

The aim of this thesis, as stated before, is to investigate the possible application of World Class Manufacturing techniques in the manufacturing of fibre-cement sheets. Some of the techniques, and in particular Rapid Tool Setting, were applied in the Sheet Plant of the Everite company in Brackenfell. The purpose of this chapter is to supply the reader who does not know the fibre-cement industry, with relevant background information about the industry and the production line on which the improvements were implemented.

The WCM techniques were implemented on S28 sheet manufacturing line. Three types of profiled sheets are produced on this line, namely Bigsix, Canadian Pattern and Victorian Pattern. In addition the machine produces wet sheets for the Moulded Goods section and can be modified to produce flat sheets if necessary.

6.1 Historical background

Traditionally fibre-cement (FC) sheets have been produced with asbestos fibres and cement as the basic raw materials. Due to the present unpopularity of asbestos, many European and American FC companies have either changed to alternative fibres or sold their factories and diversified into other fields.

The Everite group of companies was founded in 1945, when the Swiss owned Eternit group built a Sheet Plant and Pipe Plant at Brackenfell, Cape Town. By 1987 Everite had built factories in Johannesburg and East London. Up to 1987, Everite's main competitors in the FC field were Turnall and Newall who had factories in Durban, Port Elizabeth, Cape Town (Kuis River), Garankua and Zimbabwe.

In 1987 Everite acquired ownership of Turnall's South African interests and subsequently closed the factories in Port Elizabeth, Kuis River and Garankua. In 1989 the East London factory was closed in a rationalisation exercise. The group thus owns 3 FC factories, namely Brackenfell, Johannesburg and Durban, while also owning 50% of the Unipipe factory in Bloemfontein. Everite also owns a few subsidiary companies in the building industry such as Paxit, Agriplas, Tiger Tiles and Vaal Potteries.

The main products of the FC division are asbestos pipes, asbestos and cellulose fibre sheets and hand moulded FC products. The only Southern African competitors in the FC field are Rocla, who have a pipe plant in Johannesburg and Turnall and Newall, Zimbabwe. Non-FC pipe products competing in the same market include concrete, steel and PVC pipes. In the roofing market, steel and concrete tiles dominate, while gypsum products oppose Everite's range of internal partition and ceiling boards.

For the past few years Everite has actively researched the

manufacturing of non-asbestos products. The greatest successes so far have been achieved in sheet manufacturing. At the present moment all of the flat sheets produced at the Brackenfell Sheet Plant are non-asbestos. These products are marketed under the name of Nutech. The company aims to have converted all of its sheet products to Nutech by 1992.

6.2 Brackenfell Sheet Plant

The Sheet Plant has 4 Hatchek type sheet machines, namely S25, S26, S27 and S28. In addition there are two slate coating lines, a hard sheet cutting area, despatch stockyard and various auxiliary plants. Figure 6.1 shows the various areas and the main product flows through the factory.

6.3 Product range

The full product range for S28 is indicated in table 6.1. Three different profiles are produced namely Bigsix, Canadian Pattern and Victorian Pattern. Only standard lengths are produced, but sheets can be cut by the Hard Sheet Cutting section to any required length under 3,6m.

Different lengths of sheets are obtained on the machine by changing the production roller size and by changing the cutting frame. (See sections 6.4.2 and 6.4.3) Different thicknesses are obtained by increasing the number of turns of the production roller per sheet.

Figure 6.1 SHEET PLANT LAYOUT AND PRODUCT FLOW

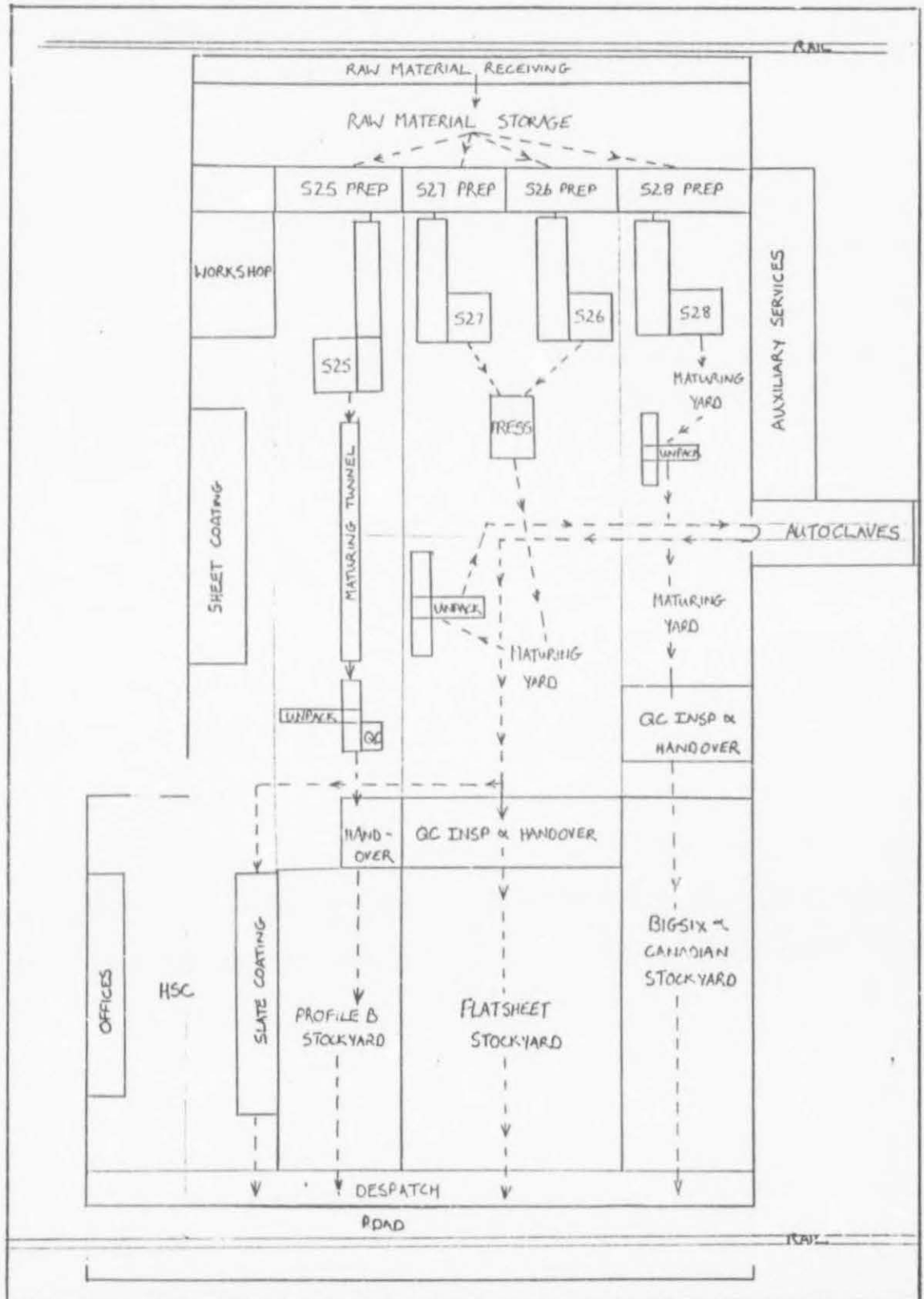


Table 6.1 S28 PRODUCT RANGE

	Bigsix AC	Bigsix SC	Bigsix Nutech	Canadian Pattern AC	Victorian Pattern AC	Moulded Goods AC
Thick- ness (mm)	6,3	6,3	7	6,3	4,5	4,5 5,4 6,3 7,2 8,1 9,0
Length (m)	1,5 1,8 2,1 2,4 2,7 3,0 3,3 3,6	1,5 1,8 2,1 2,4 2,7 3,0 3,3 3,6	1,5 1,8 2,1 2,4 2,7 3,0 3,3 3,6	1,5 1,8 2,1 2,4 2,7 3,0 3,3 3,6	2,7	3,6

AC sheets are defined as those containing asbestos and cement as main raw materials. In SC (steam cured) sheets, up to 60% of the cement is replaced with silica. These sheets have to be autoclaved for 10 hours at 180°C before reaching full strength while AC mature

naturally. The autoclave is a pressure vessel in which the product is brought into contact with steam. The first advantage of producing SC sheets is that the SC raw material mix is 40% cheaper than the AC mix. Secondly, SC sheets reach full strength after only 10 hours of autoclaving while AC takes up to 21 days to mature sufficiently.

Nutech sheets must be autoclaved to activate the special additives which prevent cracks forming in the product. Canadian and Victorian Pattern can not be autoclaved due to a shortage of autoclave carriers.

6.4 The Process

Fibre-cement sheets (both FC and Nutech) are produced using the Hatchek process. It is a filtration or dewatering process, similar to the paper-making process.

S28 sheet manufacturing line consists of four sections, namely a raw material preparation area, a dewatering machine, an offtake and an unpacker. Figures 6.2 to 6.4 are process flow charts of the various products produced on the machine.

Figure 6.2 PROCESS FLOW CHART - BIGSIX AND CANADIAN PATTERN AC

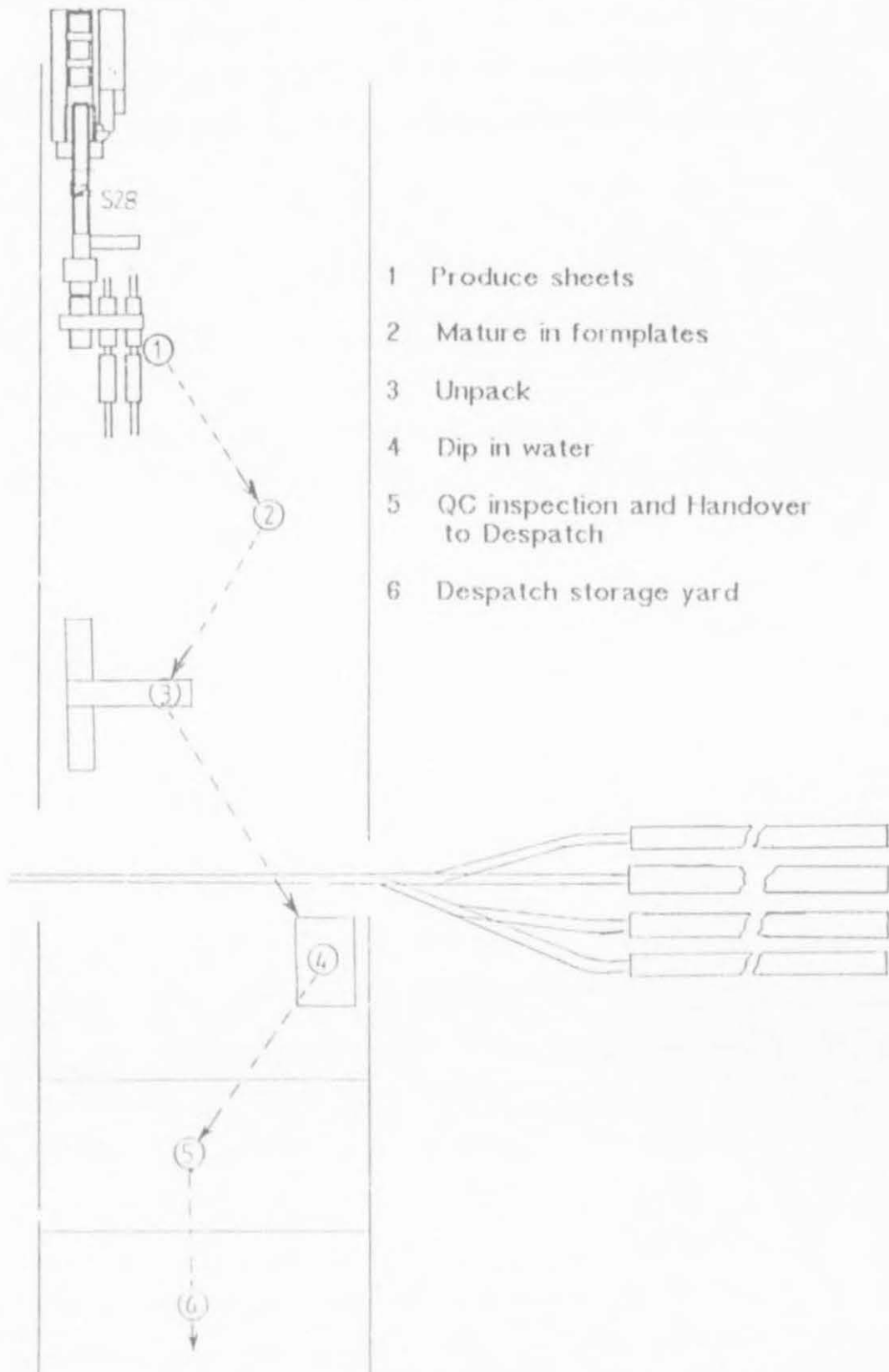


Figure 6.3 PROCESS FLOW CHART - BIGSIX SC AND NUTECH

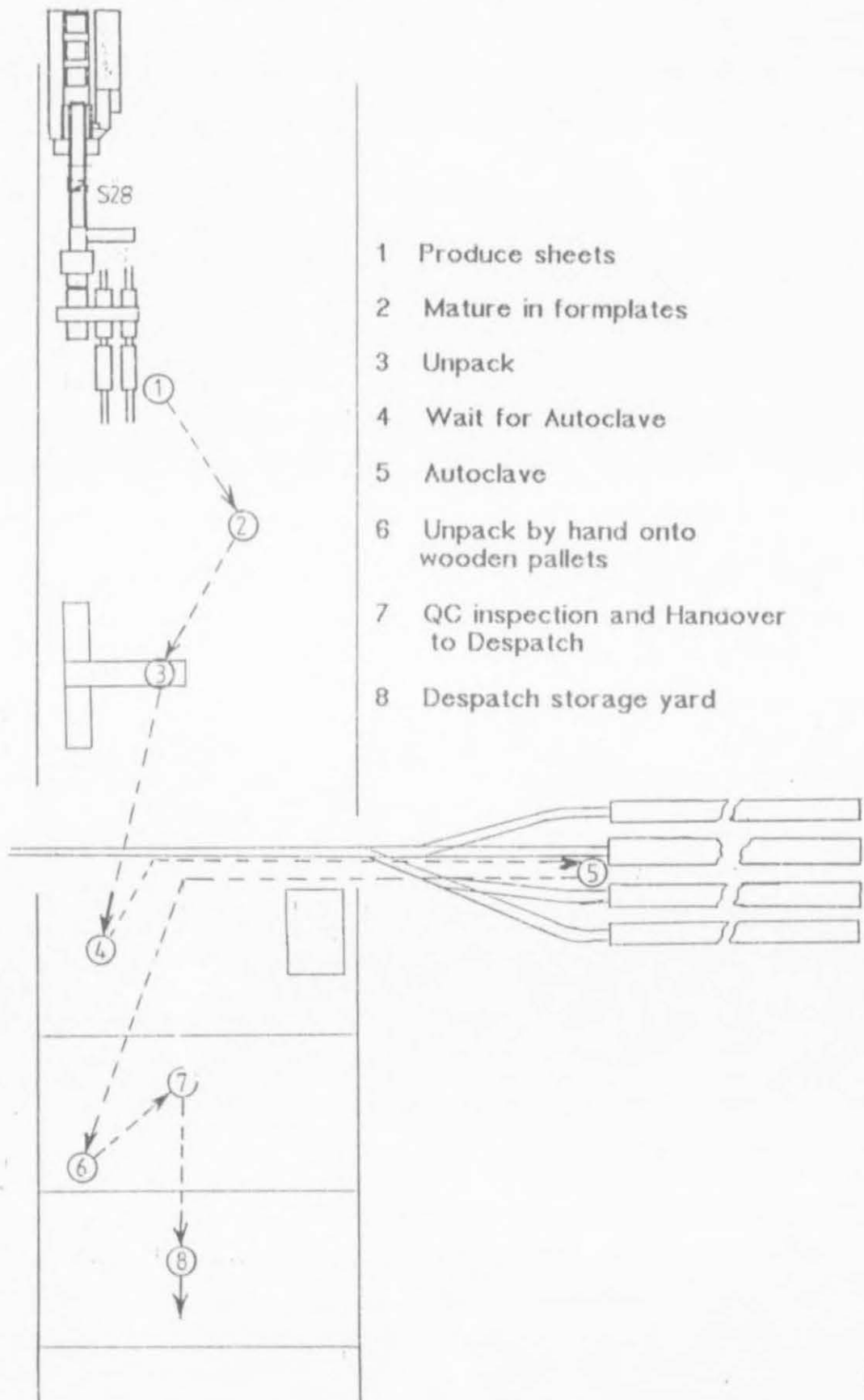
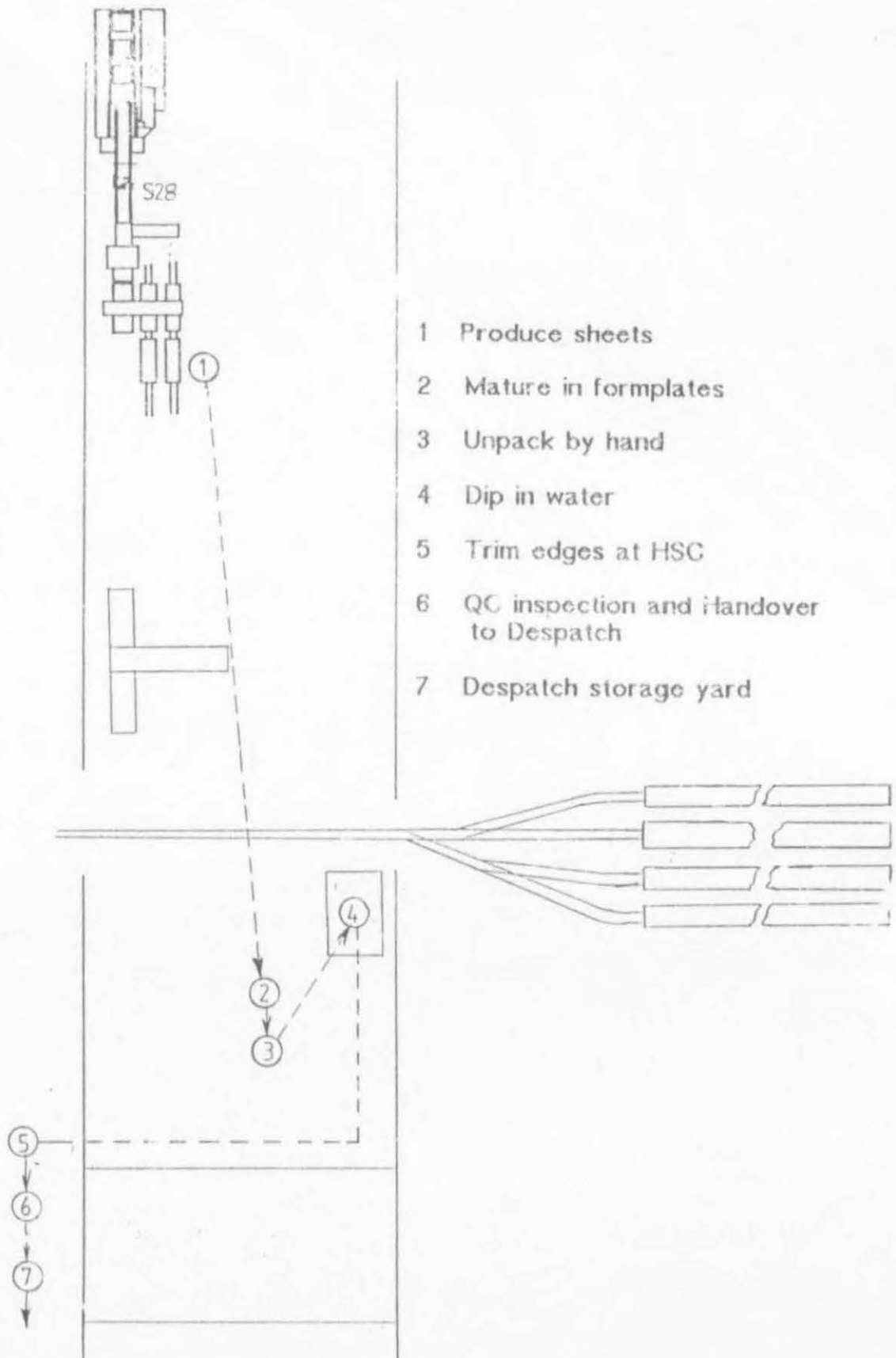


Figure 6.4 PROCESS FLOW CHART - VICTORIAN PATTERN



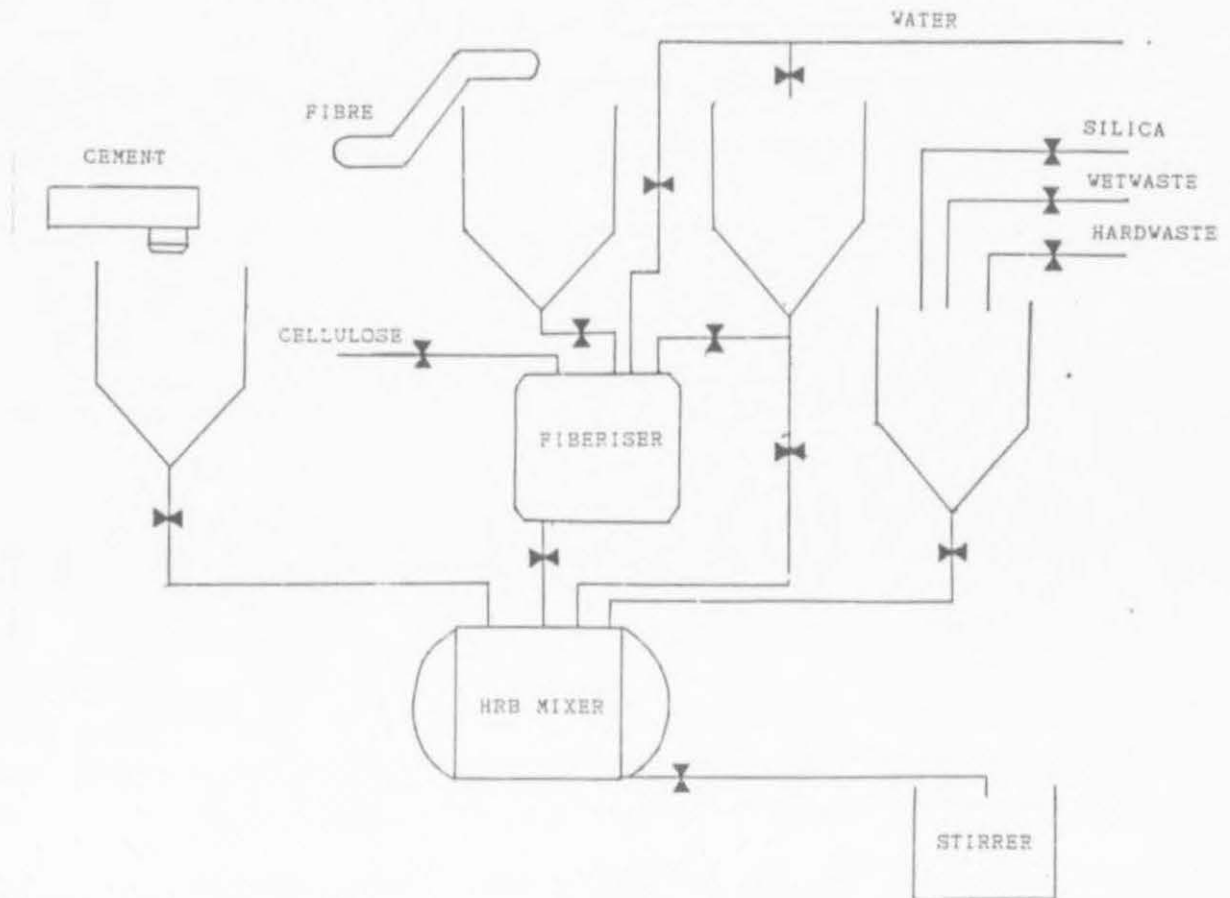
6.4.1 Raw material preparation

In the raw material preparation area, the various raw materials are prepared and mixed. A typical mix could contain either asbestos or cellulose fibres, cement, silica, additives, crushed hardwaste and water. Asbestos fibres are crushed and opened in a kollergang and fiberiser. Cellulose fibres are pulped and refined in a separate plant and pumped to the preparation area. Cement is kept in a bulk storage tank and fed to the mixer by a screw conveyor. Silica is mined and milled on the premises and pumped to a bulk storage tank from where it is dosed into the mix.

The mixing and dosing of all raw materials at S28 are controlled by a process control computer. One operator starts and stops the process, monitors its operation and cleans all spillages and leaks. Raw materials are weighed off in weighing vessels and mixed in an enclosed mixer. Figure 6.5 is a schematic diagram of the preparation area.

The raw materials are mixed in batches containing approximately 1000kg of dry ingredients and 2000kg of water. This slurry is transferred to a buffer vessel, called a stirrer, from where it is transferred to the dewatering machine at a steady rate. S28 machine uses roughly 4 mixes per hour.

Figure 6.5 S28 RAW MATERIAL PREPARATION PLANT



6.4.2 The Dewatering Machine

In the dewatering machine 3 rotating sieves filter the solids from the mix and deposit this mat onto a porous conveyor called a felt. The felt moves over a set of vacuum boxes where the layers are dewatered even more. The layers are then deposited onto a revolving drum, called the production roller. When a suitable number of layers are deposited onto the production roller, the sheet is cut from the roller using a cutting wire. It is then transferred to the offtake on a conveyor. Figure 6.6 shows some detail of the machine.

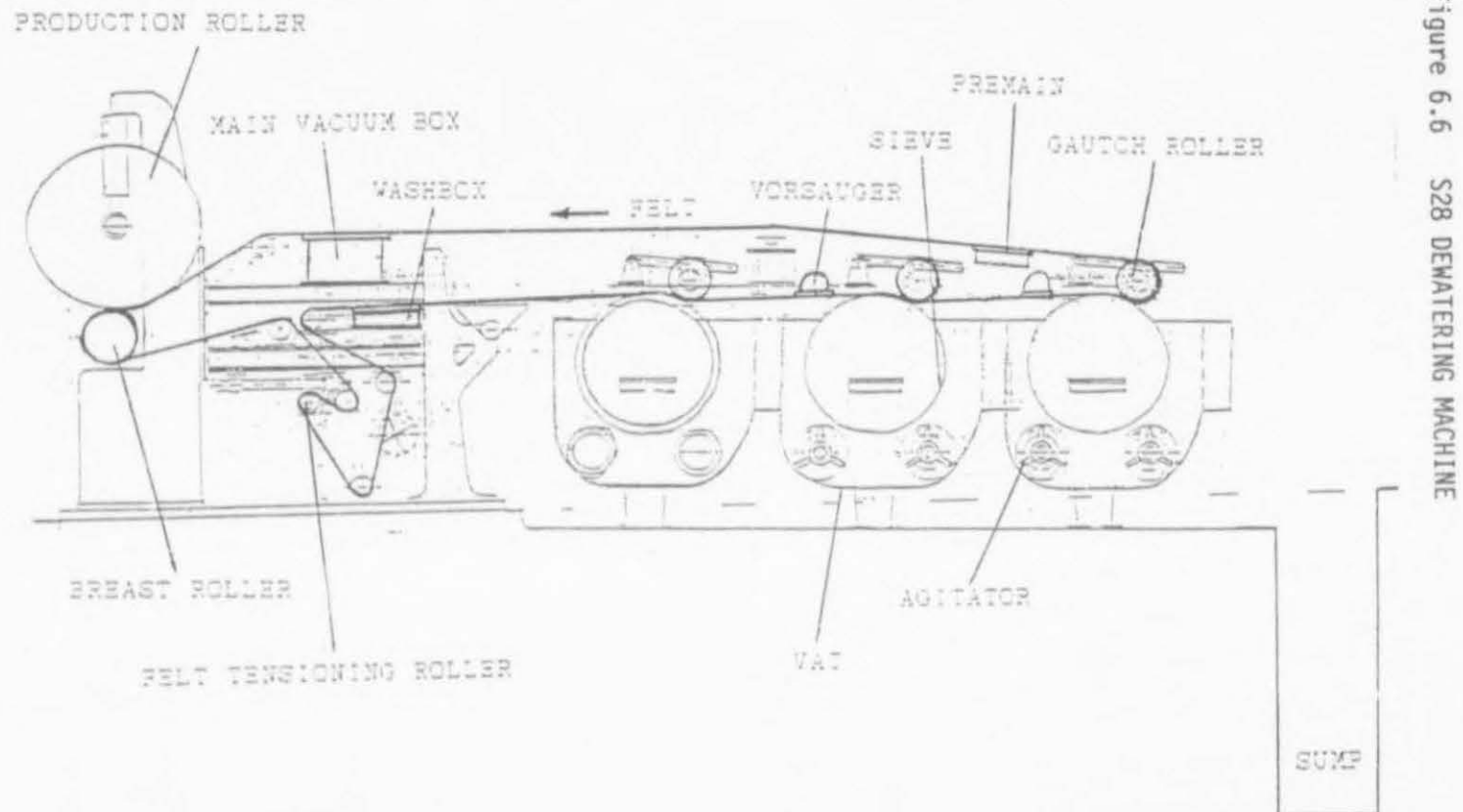


Figure 6.6 S28 DEWATERING MACHINE

6.4.3 The Offtake

The purpose of the offtake is threefold: firstly, the sheet is cut to the correct size by the wetstamp. The sheet is then corrugated and finally placed between formplates.

The wetstamp is a hydraulic press with a removable cutting blade. Various blades are available for the different products and sizes. The offcuts are fed into a wet waste dissolver where it is dissolved and pumped back to the stirrer.

After being cut to size the sheet is transferred by means of a vacuumbox to the folder. The folder, which is mounted on a trolley, is a flat box covered with a rubber sheet. The rubber sheet has holes in it through which vacuum is applied to the wet FC sheet, sucking it onto the folder. The folder then changes shape to take up the profile of the finished sheet. A profiled vacuumbox then picks up the corrugated sheet and places it between two steel formplates. These formplates also have the profile of the finished product.

The formplates and wet sheets are stacked on a pallet (carrier). When the required number of sheets is stacked on the carrier, the trolley on which it is mounted is moved out from underneath the offtake, and an overhead crane removes the carrier to the intermediate maturing yard. The crane is also used to place full formplate carriers on the formplate trolley and move the empty

formplate carriers to the mixstack trolley.

6.4.4 The Unpacker

After 12 to 24 hours in the maturing yard, the mixstacks are moved to the unpacker where the sheets are stripped from the formplates and the formplates oiled. At this stage the cement in the sheets has set sufficiently to permit the sheet to retain its shape without the formplate. The unpacker operators also inspect the sheets and remove any rejects. Rejects are inspected again by a QC inspector and classified as either scrap, recuts or degraded. Scrap sheets are destroyed, recuts are recovered at Hard Sheet Cutting and degraded sheets are sold for special applications.

Asbestos cement (AC) sheets are stacked on wooden pallets at the unpacker. These stacks are then dipped in water and transported to the inspection/handover area. Here a sample inspection is performed on completed batches and the batches handed over to the despatch stockyard. Laboratory samples are tested for breaking load after 1 week. If the test sheet passes the breaking load test, the batch is released for despatch to customers. Rejected batches are retested one week later and, if they still fail, are destroyed.

Steam cured (SC) and Nutech sheets are loaded onto steel pallets and autoclaved. After autoclaving, these sheets have to be reloaded onto wooden pallets before inspection and handover to Despatch. This double handling is required due to the fact that the wooden

pallets burn in the autoclave. SC sheets can be tested for breaking load immediately after autoclaving.

Victorian Pattern sheets are unpacked by hand, as the unpacker can presently only accept Canadian Pattern and Bigsix sheets. This is a labour intensive and time consuming operation. Six people plus a supervisor take two to three days to unpack and oil 700 formplates manually. The sheets are then transported to the Hard Sheet Cutting area where the sides are trimmed as the offtake is not capable of producing an acceptable finish on the sheet sides. After trimming, the sheets are inspected and handed over to Despatch.

6.5 Capacity

S28 is capable of producing 700 m²v per hour. The m²v is an internal unit of measuring production volume and is defined as a wet sheet, 1m X 1m X 5mm. The machine's output is limited by the felt speed, layer thickness and offtake capacity.

At the present moment the felt speed is limited to 65 m/min. The maximum layer thickness at this speed is 0,9mm. Not enough vacuum is available to dry a thicker layer sufficiently. The offtake can process 194 sheets per hour. Setting offtake at a higher speed causes too many rejects due to sheets not corrugating properly.

The maximum number of sheets which can be produced per hour (theoretically), can be calculated using the following formula:

$$\frac{\text{Felt speed(m/min)} \times 60}{\text{Number of sheets} = \text{Layers per sheet} \times \text{Roller circumference(m)}}$$

Number of sheets = Layers per sheet X Roller circumference(m)

Using the above formula, the following table of product capacities can be calculated.

Table 6.2 S28 PRODUCTION CAPACITY

PRODUCT	SIZE	M2V/ SHEET	ROLLER CIRC	FELT SPEED	NUMBER LAYERS	SHEETS/ HOUR	M2V/ HOUR
BIGSIX	2.1	2.91	2.548	60	7	194	565
	2.4	3.33	2.548	60	7	194	646
	2.7	3.74	2.86	60	7	186	696
	3.0	4.16	3.163	60	7	170	707
	3.3	4.58	3.445	60	7	155	710
	3.6	4.99	3.74	60	7	140	699
CANADIAN PATTERN	2.1	3.22	2.548	60	7	194	625
	2.4	3.69	2.548	60	7	194	716
	2.7	4.15	2.86	60	7	186	772
	3.0	4.61	3.163	60	7	170	784
	3.3	5.07	3.445	60	7	155	786
	3.6	5.53	3.74	60	7	140	774
VICTORIAN PATTERN	2.7	2.70	2.86	45	6	157	425
	3.6	3.60	3.74	45	6	120	433

CHAPTER 7

SETUP TIME REDUCTION ON A FIBRE-CEMENT SHEET MACHINE

Setup Time Reduction is one of the most important building blocks of Just-in-Time production. Reducing setup times makes short runs of a particular product economical. Being able to produce short runs of a product allows a company to produce only what is required, when it is required; the JIT ideal. More information on JIT and the advantages of reduced setup times are supplied in Chapter 2.

The purpose of this chapter is to show the results achieved in a setup time reduction exercise carried out on S28 sheet machine at Everite, Brackenfell.

7.1 The Need for Setup Time Reduction on S28

During 1990 the need for setup time reduction between products on S28 became obvious. This was brought about by the addition of a third profile to the present product range. Up to 1988, S28 had only produced Bigsix and Canadian Pattern sheets as well as wet sheets for moulded goods. Bigsix makes up more than 90% of the production volumes and is made in production runs of up to 8 weeks. The machine is then converted to produce Canadian Pattern for 1 week or less. This conversion between products takes up to 4 hours and involves changing the cutting frame, production roller, folder, corrugated lifter, and formplate lifter. The suction boxes on the

unpacker also have to be changed. The profile of the sheets has to be set once the machine starts running.

During the run of a particular product, changes are made between various sizes of the same product. These changes generally take half an hour and involve changing the production roller and cutting frame. Due to the half an hour lost between changes, an agreement was reached with the production planner that production runs of one particular size would never be shorter than 4 hours. Table 7.1 provides a list of the products produced during the 49 production weeks of 1989/1990.

Early in 1989 the need was identified for a small corrugated sheet in the coastal regions. This product, named Victorian Profile, would be used for the renovation of Victorian buildings as well as for the Neo-Cape Colonial style of architecture presently found in the Cape area. The product is to compete with corrugated steel sheets and offers the advantage of being resistant to rust.

Brackenfell factory had previously made a product called Ardex, which was a lightweight corrugated sheet, similar to Victorian Profile. The equipment was still available and could be modified to produce Victorian Profile. Only 567 formplates were available, but 400 more were discovered at the Durban factory. These were in a bad condition and up to now 200 have been cleaned and put into use.

Bigsix and Canadian Pattern can be made continuously for weeks on

Table 7.1 PRODUCTION SCHEDULE FOR 1989/1990

WEEK	PIGSIX							CANADIAN PATTERN							VICTORIAN			
NUMBER	1.5	1.8	2.1	2.4	2.7	3	3.3	3.6	1.5	1.8	2.1	2.4	2.7	3	3.3	3.6	2.7	3.6
1			10		20	30	10	12										
2			9	15	12		8										5	5
3			15	30		18		10									5	
4					21	30		10			5	5	5					
5			13	7	13	31		10									4	
6			10	12	12		18	10										
7					15	24	10	15									5	5
8			15	19	10	14		10									5	
9			8	10		10	10	8			12	16	16			6		
10		10		19	6	20	18	14										
11			10		12	20	25	20										
12		8		20	10	20		18									5	
13											15	20	16	17	8	11		
14				18		30	16	30										
15				21		29	13	40										
16	10		13		33	13	15	10										
17		10	15	15		27	20	23										
18			12	10	15	34	30	33									5	
19			10	15	25	25	31	15									17.5	17.5
20		8	20	15	22	20	10	22										
21				15		20	20	20		7	6		15	8	25			
22	10	10	20	15	25	20		31									5	
23					20	40	31	45									5	
24												4	6	4	10			
25																		
26																		
27																		
28		15	10		17	30	20	20										
29		12	10	20	8	30	20	36										
30			10	10	15	56	10	15										10
31						30		11		13	14	15	15	12	25			
32	10		16				60	40										
33	10		16				60	40										4
34	10		26	15			30	50										10
35				20	20		25	10		12	15	10	24				5	
36						35	24	19	4					15	30	10		
37		13	18		15	27	28	28									7	
38				20	16	25	27	47										
39	8		27		37		29	29									9	
40																		
41				20			29								7	36		10
42					24	30		37									10	
43		15		35			13	39									10	
44			24		22		29	27									10	
45		10					60	20	16								10	
46					35	24	32										10	10
47			5	11	14	17		6									10	
48										5	5		18	6			10	
49		10	20			20		15									10	
50							35	30									10	
51			35															10
52			10	15		20		13									10	
TOTAL	58	1121	1407	1427	1494	1879	1749	1749	0	4	69	81	66	95	60	1143	1172	181

end because of the large amount of formplates and carriers available. As the sheets mature in the formplates and are unpacked, the formplates are sent back to the machine and filled with wet sheets. Unfortunately, the 750 Victorian Profile formplates are not enough to ensure continuous production of this product. After 5-7 hours all of the formplates are filled and the machine is changed to produce another profile. After 24 hours the sheets are unpacked and the formplates oiled. Only then can the product be made again.

In order to meet the weekly demand of +1500 Victorian Pattern sheets, two runs of the product are required per week. The machine is thus forced to work in a Just-in-Time mode, making shorter and more frequent runs of a particular product. Reducing setup times thus becomes imperative in order not to make the product uneconomical to produce.

7.2 Reducing setup times between different sizes of the same product

It can be seen from table 7.1 that two types of setup changes take place on S28 machine, namely changes between products and changes between different sizes of the same product. This section deals with changes between different sizes of the same product.

Changes between different sizes of the same product have traditionally taken half an hour. Somewhere, in the past, the time limit of half an hour had been set, and up to the time of this exercise has never been questioned. The result was that the foreman

had always booked half an hour towards a production change. Whether it really took that long is uncertain. It is believed that it often took shorter, but that this time was used to produce extra and so improve production efficiencies. Fitting a recorder to the machine showed that changes took between 20 and 40 minutes. The 40 minute changes occurred when problems were experienced with fitting the cuttingframe.

7.2.1 Traditional method of changing production

Table 7.2 shows the various steps that were required to change production between different sizes of the same product. Figure 7.1 is a PERT diagram of the operation.

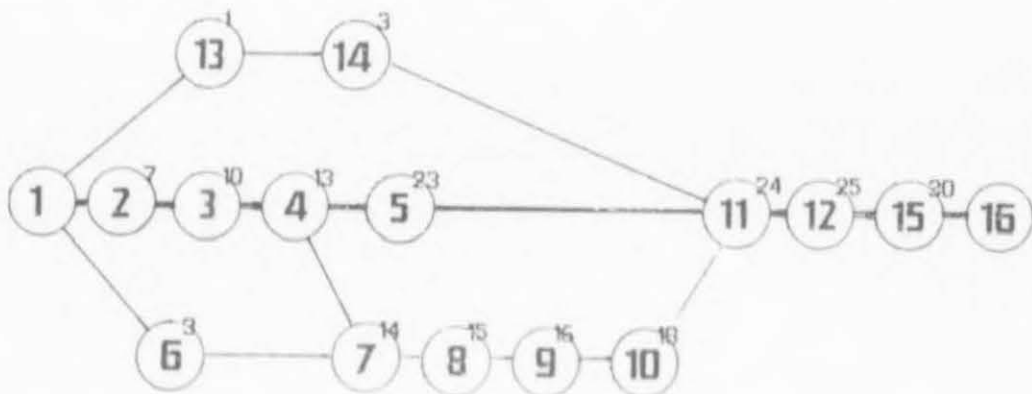
It can be seen from table 7.2 that this type of production change consists of three main activities, namely changing the cuttingframe, changing the production roller and changing the offtake settings (cuttingframe depth, vacuumbox and folder length, taping up equipment). All of these activities are carried out only after the machine has stopped.

Changing the cuttingframe and production roller can not occur at the same time, since only one overhead crane is available. The hooks of the crane have to be changed between these operations because a special hook is required to transport the production roller.

Table 7.2 CHANGING BETWEEN SIZES BEFORE IMPROVEMENTS

Step No	Operation	Internal/External	Time (min)	Critical Time	Performed by
1	Stop machine.				
2	Remove cuttingframe from wetstamp	I	7	7	Operator Assistant
3	Hook cuttingframe, place in rack	I	3	3	Crane
4	Place new cuttingframe on machine	I	3	3	Crane
5	Fit new cuttingframe to wetstamp	I	10	10	Operator Assistant
6	Lift production roller, remove bolts.	I	3		Cutter Mixer
7	Change crane hook	I	1		Crane
8	Remove roller, place on rack	I	1		Crane Cutter
9	Place new roller on machine	I	1		Mixer Crane Cutter
10	Fasten roller bolts; lower roller	I	2		Cutter Mixer
11	Start machine; produce first sheet	I	1	1	Cutter
12	Set cuttingframe depth	I	1	1	Operator
13	Change vacuumboxes lengths	I	1		Foreman
14	Tape up folder	I	2		Foreman
15	Set profile	I	5	5	
16	Commence production				
Total time involved			41		
Critical Time				30	

Figure 7.1 CHANGING BETWEEN SIZES BEFORE IMPROVEMENTS



The cuttingframe is held to the wetstamp by eight bolts. Two spanners are required to undo each bolt. The cuttingframe is then dropped onto the translation trolley and removed from under the wetstamp. Inserting a new cuttingframe is the exact reverse procedure.

The depth of cuttingframe blades differ from frame to frame. This happens because the blades get sharpened when blunt and then become shorter. The frame's cutting depth can be set before startup, but this setting is not very accurate, with the result that the sheets do not get cut through completely.

A fan on the wetstamp sucks the cut sheet into the frame so that it can be dropped onto the translation trolley. When the cuttingframe gets changed, some of the holes in the wetstamp through which this vacuum is applied, are opened. This causes a loss in vacuum and the sheet is not sucked into the frame. This only happens on certain of the shorter frames and occurs intermittently. The operator thus does not tape up the wetstamp with every change, he first waits to see if it is necessary.

The vacuum lengths of the flatsheet lifter and corrugated lifter are changed by opening or closing a set of valves on the boxes. If these valves do not operate correctly, it is necessary to use plastic and adhesive tape to seal the lifters.

7.2.2 Improvements implemented

(i) Clamping the cuttingframe - The first improvement had been suggested by the workers themselves and had been practised secretly before the exercise commenced. Until then the workers were afraid that they would be disciplined if they did not work strictly according to procedure. This improvement involves unbolting four of the eight holding clamps which secures the cuttingframe to the wetstamp before stopping the machine. The moment the last sheet is cut, the remaining four clamps are unbolted and the frame removed. The exact reverse occurs when fitting the new frame. Only four clamps are used to secure the frame and, only after the machine has started, are the remaining four fixed. This effectively halves the clamping time of the cuttingframe.

(ii) Eliminate setting the profile - In the past all cuttingframes had been fitted with locating pins which fitted into holes underneath the wetstamp. The purpose of these pins was to ensure that the frames were all fitted in a standard position. This would ensure that when a new size was made, the cut sheet would have the same position on the folder, and thus the same profile, as the previous size.

With time the pins had been removed, mainly because they were not very accurate. The pins had to be significantly smaller than the holes to accommodate the bending action when the frame was inserted. The frame could thus not be positioned very accurately and the

profile had to be set after every change.

Pins with an improved taper design are being fitted to all cuttingframes. These are more accurate and can accommodate the bending action of the frame. The need to set the profile after a change has now been eliminated. Figure 7.2 shows the old versus the new design.

Figure 7.2 IMPROVEMENT IN CUTTING FRAME PIN DESIGN

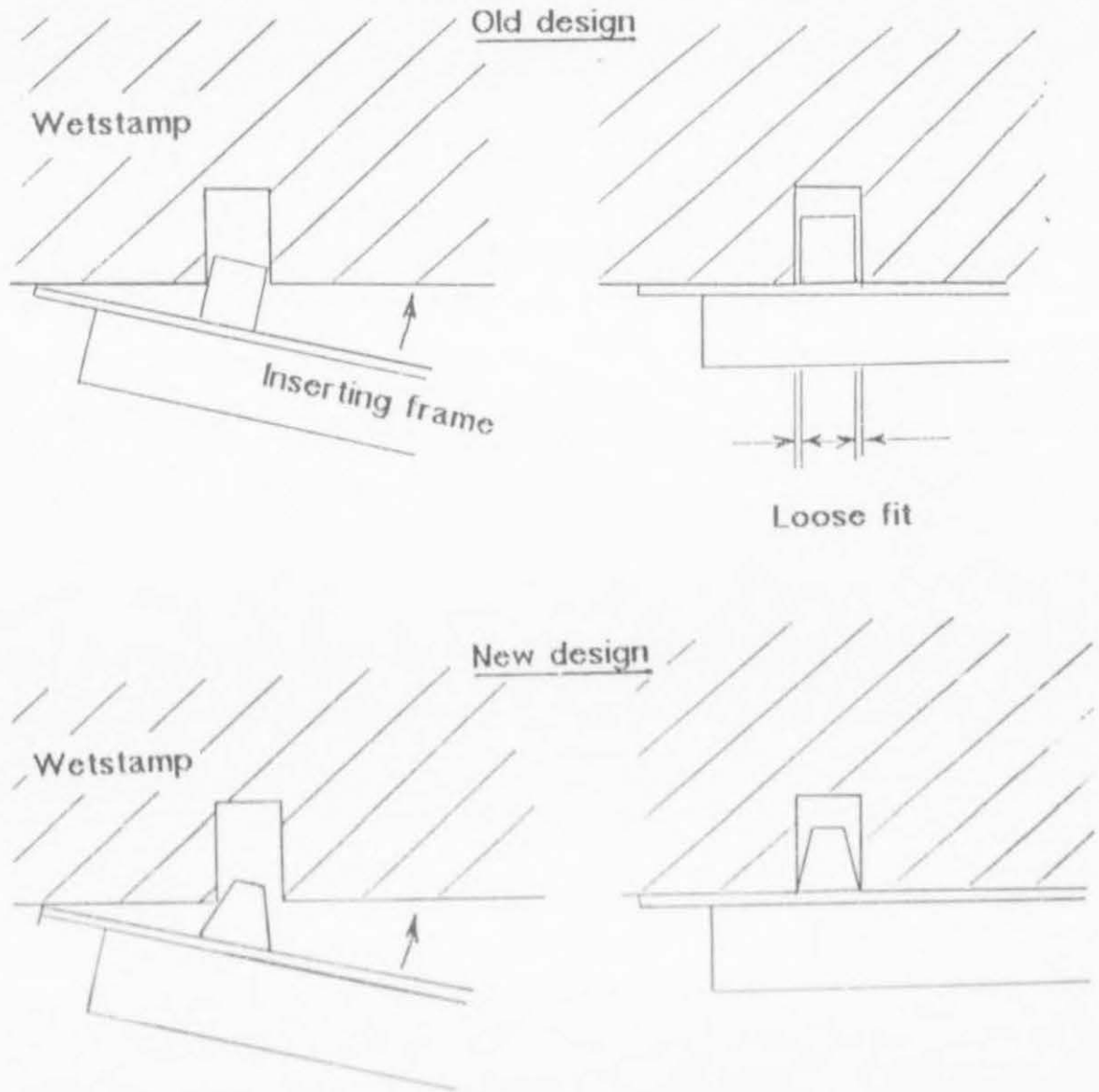
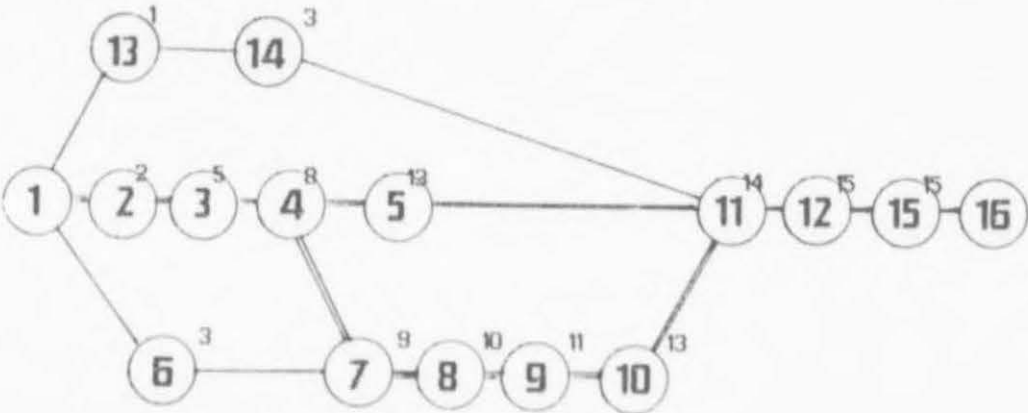


Table 7.3 and figure 7.3 show the results of the improvements implemented so far. An improvement of 15 minutes or 50% had been achieved.

Table 7.3 CHANGING BETWEEN SIZES AFTER IMPROVEMENTS

Step No	Operation	Internal/External	Time (min)	Critical Time	Performed by
1	Stop machine.				
2	Remove cuttingframe from wetstamp	I	2	2	Operator Assistant
3	Hook cuttingframe, place in rack	I	3	3	Crane
4	Place new cuttingframe on machine	I	3	3	Crane
5	Fit new cuttingframe to wetstamp	I	5	5	Operator Assistant
6	Lift production roller, remove bolts.	I	3		Cutter Mixer
7	Change crane hook	I	1		Crane
8	Remove roller, place on rack	I	1		Crane Cutter Mixer
9	Place new roller on machine	I	1		Crane Cutter
10	Fasten roller bolts; lower roller	I	2		Cutter Mixer
11	Start machine; produce first sheet	I	1	1	Cutter
12	Set cuttingframe depth	I	1	1	Operator
13	Change vacuumboxes lengths	I	1		Foreman
14	Tape up folder	I	2		Foreman
15	Set profile	I	0	0	
16	Commence production				
Total time involved			26		
Critical Time				15	

Figure 7.3 CHANGING BETWEEN SIZES AFTER IMPROVEMENTS



7.2.3 Planned improvement

In addition to the implemented improvement, the following improvements are planned:

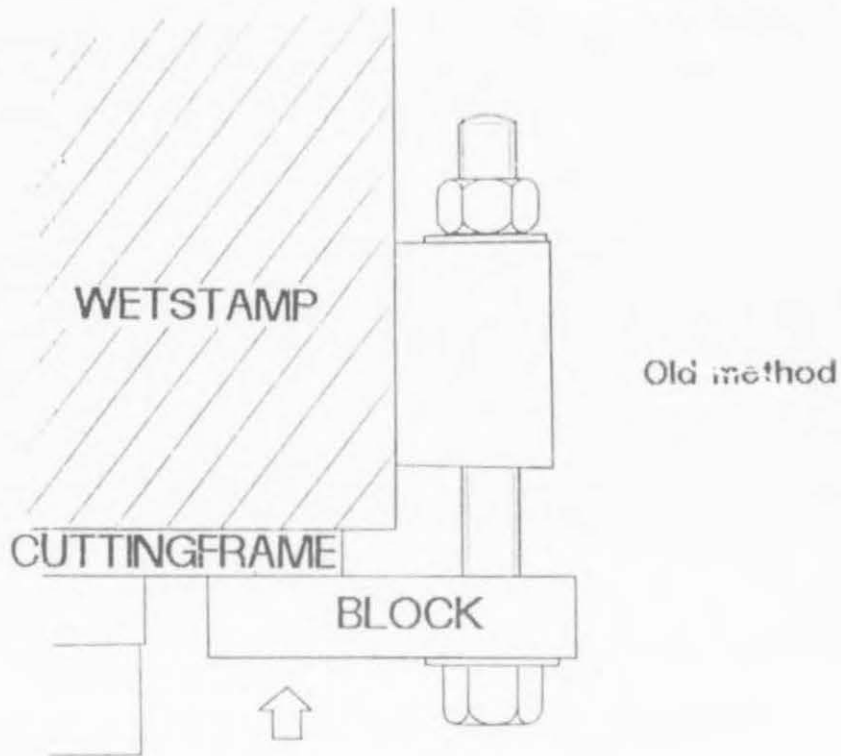
(i) Eliminate nuts or bolts - A design for quick acting toggle clamps is being investigated to replace the nut and bolt arrangement presently being used to clamp the cutting frame to the wetstamp.

Figure 7.4 shows the new versus the old design. Fixing the cuttingframe to the wetstamp should take only a few seconds with the new clamps.

(ii) Taping the cuttingframe - The cuttingframes are to be modified so that they cover all the openings under the wetstamp. This will eliminate the need to tape up the wetstamp with plastic. Figure 7.5 illustrates this principle.

(iii) Parallel operations - Crane capacity should become a limiting factor once all of the above changes have been implemented. Crane #2 can then be used to assist in the changes. Crane #1 will change the production roller and crane #2 the cuttingframe. Crane #1 will have to prepare for the change by changing hooks and placing the new roller near the machine before the machine is stopped. Figure 7.6 illustrates this principle.

Figure 7.4 IMPROVED WETSTAMP CLIPPING METHOD



Suggested improvement

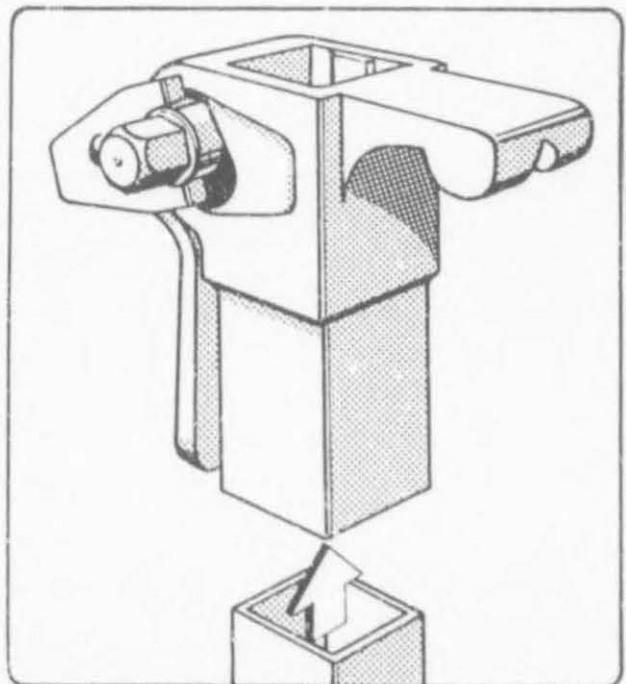
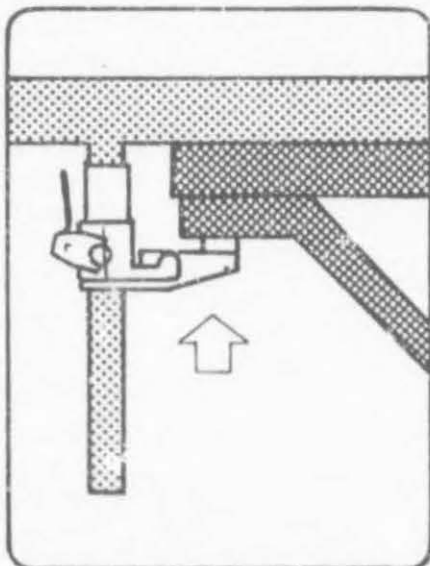
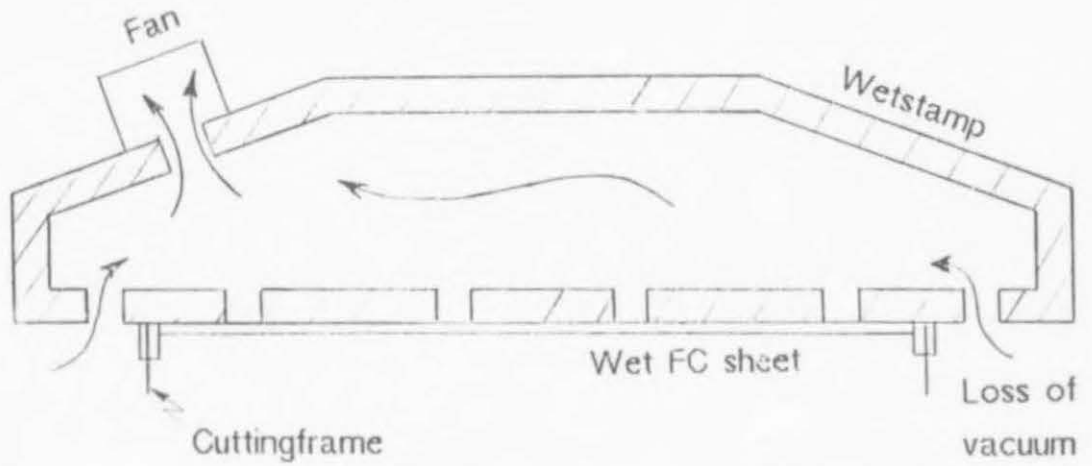
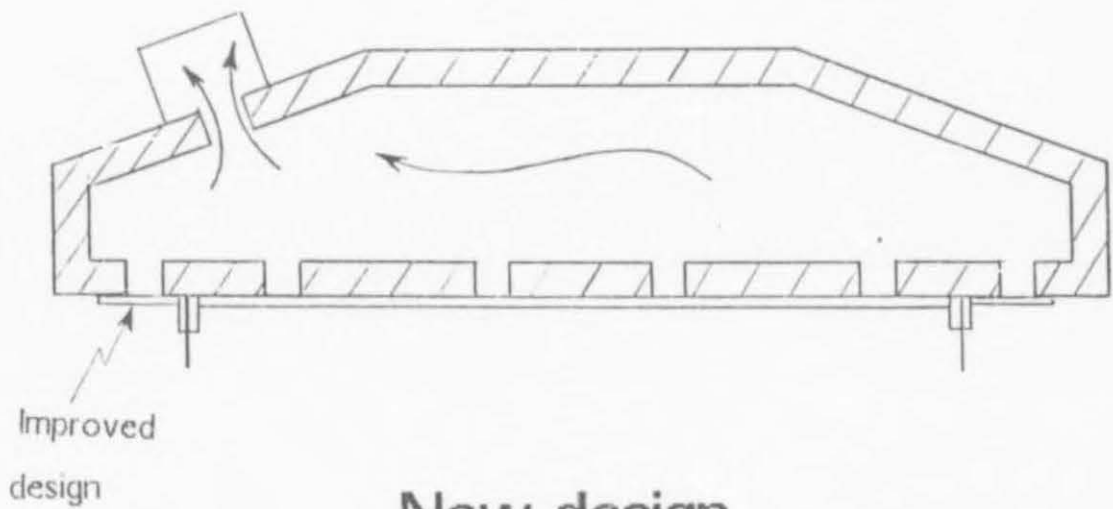


Figure 7.5 IMPROVED CUTTINGFRAME DESIGN

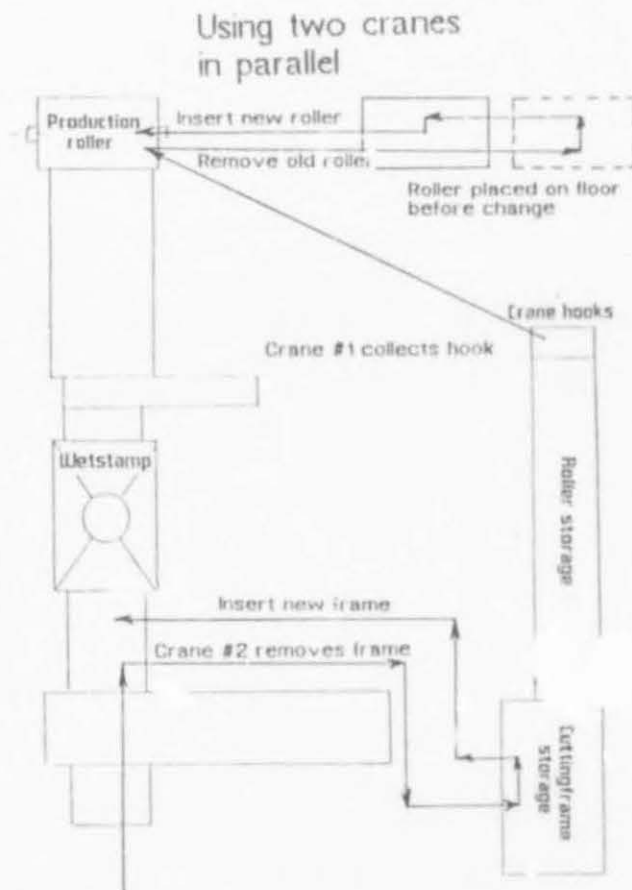
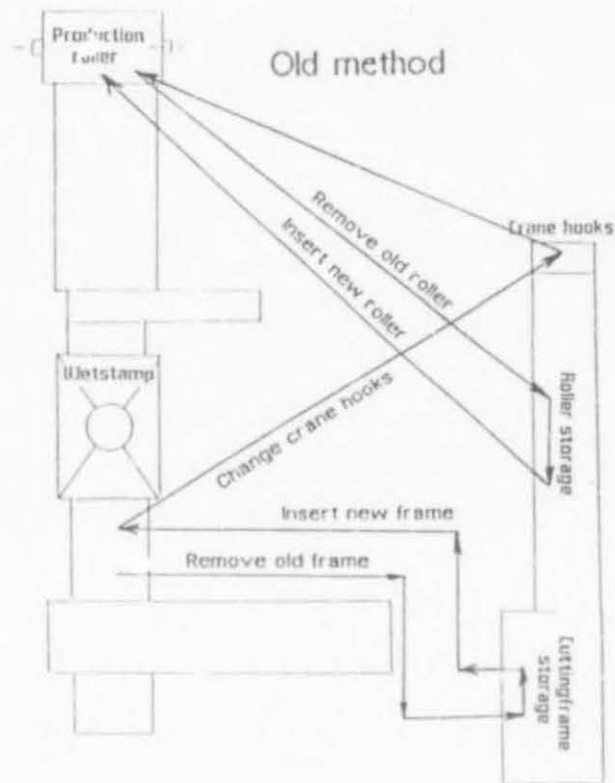


Old design



New design

Figure 7.6 PARALLEL OPERATIONS



(iv) Alternatives to the wetstamp - An alternative to wetstamp cutting of the sheet should be investigated. Highspeed rotating blades are used at S25 machine with reasonable success. Overseas companies use waterjets or compressed air to cut wet FC sheets. All of these alternatives have the advantage of being easy and fast to change from one size to the next. The changing mechanisms can be automated and computer controlled for speed and accuracy. A further advantage of these systems is that non-standard sizes can be made at no further cost.

Changing from one size to the next on S28 would then only involve changing the production roller and adjusting the sheetlifters' lengths. Changing the cutting size would be accommodated by feeding the new size into the process control computer.

7.3 Reducing setup times between various products on S28

The second, and more demanding, type of change found on S28 is changing between products, e.g. changing from Bigsix to Canadian, or from Canadian to Victorian Pattern etc. Until 1989 these changes were very infrequent (once or twice every two months). The result was that the machine operators were relatively unskilled in changes. Typically a change would take 3,5 to 4 hours to complete and the foreman and supervisor did most of the work.

In 1989 Victorian Pattern was introduced and changes had to be made twice or even three times per week. Due to improvements implemented

and the operators becoming more skilled, the average time per change has steadily been decreasing. At the present moment, changes take \pm one hour and a target of 30 minutes is set for 1991.

7.3.1 Traditional method of changing product type

Table 7.4 shows the various steps that are required to change the product type at S28. Until 1989 the foreman supervised all of these activities. They thus occurred in the same sequence as listed in table 7.4. The only exception was the changing of the cutting frame which the operator performed without supervision.

A typical change would thus take 200 minutes. Unfortunately problems usually occurred and 240 minutes became the norm.

7.3.2 Improvements implemented

(i) Parallel operations - Once again the biggest improvements were obtained by organising the work properly. As the workers became more skilled in the various facets of a production change, the foremen became more confident. The foremen thus allowed the workers to do some of the work without direct supervision. This resulted in parallel operations. Certain foremen started to pull in workers from other sections on their shift to assist with the change. This was very successful and all the foremen were instructed to do the same.

Table 7.4 CHANGING BETWEEN PRODUCTS BEFORE IMPROVEMENTS

Step No	Operation	Internal/External	Time (min)	Critical Time	Performed by
1	Stop machine.				
2	Close stamping trolley throttle valve.	I			Operator
3	Remove full mixstack carrier from offtake.	I	2	2	Crane
4	Place empty carrier (new type) on mixstack trolley.	I	2	2	Crane
5	Remove full formplate carrier from offtake.	I	2	2	Crane
6	Place empty carrier on formplate trolley	I	2	2	Crane
7	Position empty carrier under formplate lifter.	I	0.5	0.5	Operator
8	Position empty carrier under corrugated lifter.	I	0.5	0.5	Operator
9	Drop corrugated lifter and formplate lifter onto empty carriers.	I	0.5	0.5	Operator
10	Stop hydraulic pump.	I	0.5	0.5	Operator
11	Close hydraulic valves on both corrugated and formplate lifters.	I	1	1	Supervisor
12	Remove holding nuts on formplate lifter.	I	12	12	Operator
13	Remove holding nuts on corrugated lifter.	I	12	12	Assistant
14	Remove vacuum pipe on formplate lifter.	I	1	1	Operator
15	Remove vacuum pipe on corrugated lifter.	I	1	1	Assistant
16	Start hydraulic pump.	I	0.5	0.5	Operator
17	Press "up" button on control table.	I			Operator
18	Open hydraulic valve on corrugated lifter, pistons pull out of lifter, close valve.	I	1	1	Supervisor
19	Open hydraulic valve on formplate lifter, pistons pull out of lifter, close valve.	I	1	1	Supervisor
20	Modify stoppers on trolleys to accomodate new carriers.	I	4		Assistant
21	Place new corrugated lifter on mixstack trolley.	I	2	2	Crane
22	Place new formplate lifter on formplate trolley.	I	2	2	Crane
23	Position new corrugated and formplate lifters under offtake.	I	0.5	0.5	Operator
24	Press "down" button on control table.	I	0.5	0.5	Operator
25	Open hydraulic valve on corrugated lifter piston, pistons move down.	I	1	1	Supervisor
26	Position corrugated lifter under piston bracket, by adjusting position of mixstack trolley.	I	1	1	Operator
27	Use pipe wrench to force piston bracket over bolts.	I	1	1	Supervisor
28	Close hydraulic valve on corrugated lifter.	I	1	1	Supervisor
29	Bolt new corrugated lifter onto piston.	I	10	10	Operator
30	Fasten vacuum pipe to corrugated lifter.	I	3	3	Operator
31	Open hydraulic valve on corrugated lifter.	I	0.5	0.5	Supervisor
32	Open hydraulic valve on formplate lifter piston, pistons move down.	I	1	1	Supervisor
33	Position formplate lifter under piston bracket, by adjusting position of formplate trolley.	I	1	1	Assistant

Table 7.4 (continued) CHANGING BETWEEN PRODUCTS BEFORE

IMPROVEMENTS

Step No	Operation	Internal/External	Time (min)	Critical Time	Performed by
34	Use pipe wrench to force piston bracket over bolts.	I	1	1	Supervisor
35	Close hydraulic valve on formplate lifter.	I	1	1	Supervisor
36	Bolt new formplate lifter onto piston.	I	10	10	Assistant
37	Fasten vacuum pipe to formplate lifter.	I	3	3	Assistant
38	Open hydraulic valve on formplate lifter.	I	0.5	0.5	Supervisor
39	Remove vacuum pipe to folder.	I	0.5	0.5	Operator
40	Remove hydraulic pipe to folder.	I	0.5	0.5	Assistant
41	Push folder out from underneath offtake.	I	1	1	Operator
42	Undo holding nuts on folder trolley.	I	10	10	Assistant Operator
43	Remove folder from trolley.	I	2	2	Crane
44	Place new folder on trolley.	I	2	2	Crane
45	Bolt new folder to trolley.	I	10	10	Operator
46	Remove tape from bottom of flatsheet lifter and tape up to new profile.	I	10	10	Assistant Foreman
47	Push folder in under offtake.	I	2	2	Supervisor Operator
48	Replace hydraulic pipe to folder.	I	1	1	Assistant Operator
49	Fasten vacuum pipe to folder.	I	3	3	Operator
50	Tape up folder for new size.	I	2	2	Assistant
51	Tape up centersheet lifter for new size.	I	10	10	Supervisor
52	Set profile positions on new folders and trolleys.	I	15	15	Foreman Operator
53	Loosen old cuttingframe, drop onto trolley.	I	5		Operator Assistant
54	Open throttle valve on stamping trolley, trolley runs out under wetstamp, close valve.	I	1		Operator
55	Remove cuttingframe to rack.	I	2		Crane
56	Place new cuttingframe on stamping trolley.	I	2		Crane
57	Open throttle valve, trolley runs in under wetstamp, close valve.	I	1		Operator
58	Fasten cuttingframe to wetstamp.	I	5		Operator Assistant
59	Line up cuttingframe.	I	5		Operator
60	Open throttle valve.	I			Operator
61	Lift production roller.	I	1		Cutter
62	Undo production roller bolts.	I	1		Cutter Mixer
63	Remove roller and replace with new size.	I	5	5	Crane
64	Fasten roller, drop roller.	I	1		Cutter
65	Prepare 2 mixes.	I	15	15	Prep Operator
66	Start machine.	I	5	5	Cutter
67	Produce first sheet.	I			Cutter
68	Set cutting depth of wetstamp.	I	3	3	Operator
69	Tape up wetstamp.	I	10	10	Supervisor Operator
70	Check profile of sheet and adjust offtake settings.	I	15	15	Operator Foreman
71	Start production.				
Total time involved			229.5		
Total critical time				201.5	

As the crane was once again a bottleneck, the work had to be planned to suit the crane's operation. The foremen and their workers, particularly the crane drivers, devised a work procedure which took this limitation into consideration. The result is the diagram shown in figure 7.7.

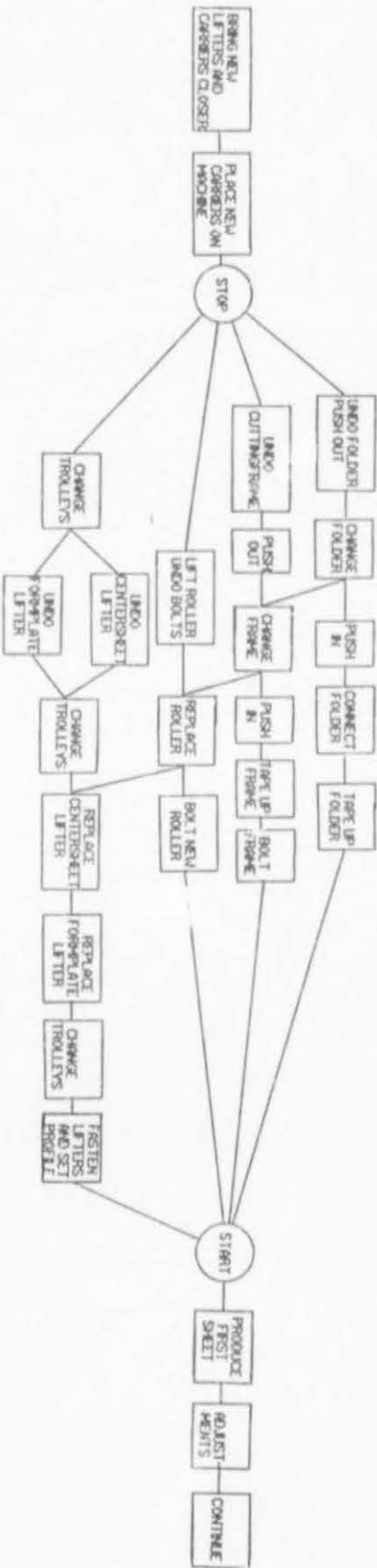
Working according to this diagram brought the total change time down from 201 minutes to 111,5 minutes. This represents a reduction of 45%.

(ii) Preparing for the change - In the past a great deal of time had been wasted by waiting for the crane to fetch and return carriers, folders and sheetlifters from the stockyard. All of this equipment was kept in the formplate stockyard, 100 metres from the machine. A slinger is required to hook loads and guide the crane. This person has to follow the crane on foot, thus wasting time.

The suggestion was then made to bring all of the required equipment closer to the machine. Before the change thus commences, the required folder, sheetlifters and carriers are placed in the walkway around the machine. Bringing the equipment closer has effectively halved the transport time.

Steps #3 to #6, namely placing empty carriers on the formplate and mixstack trolleys, are also performed before the machine stops, thus becoming external operations and saving 8 minutes.

Figure 7.7 IMPROVED WORK PROCEDURE FOR CHANGING PRODUCT TYPE



(iii) Fixing and removing the sheetlifters - Each sheetlifter is bolted to its lifting cylinders by 4 nuts. These nuts are fitted with nylon inserts to prevent them from coming undone while the machine is running. These inserts and the very fine thread used, made it very time consuming to fit or remove the sheetlifters.

A new design is being investigated, but until the present moment no feasible alternative to the nuts has been suggested. Making use of a pneumatic impact driver to fasten or remove the nuts was investigated, but the impact driver kept on stripping the threads of the nuts. As a temporary measure two sets of ratchets and sockets have been bought. The lifters can now be removed or fitted in 5 minutes each. The second ratchet enables the two lifters to be removed in parallel.

(iv) Fitting or removing the folder from its trolley - The folder is bolted to its trolley at 10 points. Until recently the Victorian Profile folder did not have its own trolley. The folder thus had to be removed from the trolley and the new folder fitted in its place. This operation took more than 20 minutes. A new trolley was thus bought to solve the problem. The folder, complete with trolley, is now replaced during a change, a saving of 20 minutes.

(v) Setting the profile on the folder and trolleys - The folder has to be set to the exact correct position to obtain a sheet with the correct profile. The folder trolley has grooved wheels which run in finely machined tracks. If a folder and trolley are thus removed as

a unit and replaced at a later stage, they should be in the exact same position they were in before.

If the folder is removed from the trolley, the profile has to be reset. Buying a trolley for the Victorian folder thus solved this problem as well. Only the mixstack and formplate trolleys now have to be adjusted after a change.

(vi) Taping up the corrugated lifter. - The Bigsix and Canadian Pattern corrugated lifters are fitted with valves which regulate the length of sheet that can be lifted. The Victorian Pattern lifter did not have these valves and had to be blanked off using plastic and adhesive tape. This was a slow and tedious job, requiring rolls of adhesive tape and lots of patience. It often had to be redone when the first sheet was made and it would not lift.

The lifter was then fitted with valves to solve the problem. Setting the lifter's length can now be accommodated by opening or closing the correct valve.

7.3.3 Results to date

Table 7.5 shows the present procedure for changing from one product to the next. According to table 7.5 the change should theoretically be performed in 67,5 minutes, an improvement of 70%. In fact, actual changes have been made in less than 50 minutes. This is due to the operators becoming more skilled in the operations.

Table 7.5 CHANGING BETWEEN PRODUCTS AFTER IMPROVEMENTS

Step No	Operation	Internal/External	Time (min)	Critical Time	Performed by
1	Stop machine.	I			
2	Close stamping trolley throttle valve.	E	2		Operator
3	Remove full mixstack carrier from offtake.	E	2		Crane
4	Place empty carrier (new type) on mixstack trolley.	E	2		Crane
5	Remove full formplate carrier from offtake.	E	2		Crane
6	Place empty carrier on formplate trolley	E	2		Crane
7	Position empty carrier under formplate lifter.	I	0.5		Operator
8	Position empty carrier under corrugated lifter.	I	0.5		Operator
9	Drop corrugated lifter and formplate lifter onto empty carriers.	I	0.5		Operator
10	Stop hydraulic pump.	I	0.5		Operator
11	Close hydraulic valves on both corrugated and formplate lifters.	I	1		Supervisor
12	Remove holding nuts on formplate lifter.	I	5		Operator
13	Remove holding nuts on corrugated lifter.	I	5		Assistant
14	Remove vacuum pipe on formplate lifter.	I	1		Operator
15	Remove vacuum pipe on corrugated lifter.	I	1		Assistant
16	Start hydraulic pump.	I	0.5		Operator
17	Press "up" button on control table.	I			Operator
18	Open hydraulic valve on corrugated lifter, pistons pull out of lifter, close valve.	I	1		Supervisor
19	Open hydraulic valve on formplate lifter, pistons pull out of lifter, close valve.	I	1		Supervisor
20	Modify stoppers on trolleys to accommodate new carriers.	I	4		Assistant
21	Place new corrugated lifter on mixstack trolley.	I	2	2	Crane
22	Place new formplate lifter on formplate trolley.	I	2	2	Crane
23	Position new corrugated and formplate lifters under offtake.	I	0.5	0.5	Operator
24	Press "down" button on control table.	I	0.5	0.5	Operator
25	Open hydraulic valve on corrugated lifter, piston, pistons move down.	I	1	1	Supervisor
26	Position corrugated lifter under piston bracket, by adjusting position of mixstack trolley.	I	1	1	Operator
27	Use pipe wrench to force piston bracket over bolts.	I	1	1	Supervisor
28	Close hydraulic valve on corrugated lifter.	I	1	1	Supervisor
29	Boil new corrugated lifter onto piston.	I	5	5	Operator
30	Fasten vacuum pipe to corrugated lifter.	I	3		Operator
31	Open hydraulic valve on corrugated lifter.	I	0.5	0.5	Supervisor
32	Open hydraulic valve on formplate lifter, piston, pistons move down.	I	1		Supervisor
33	Position formplate lifter under piston bracket, by adjusting position of formplate trolley.	I	1		Assistant

Table 7.5 (continued) CHANGING BETWEEN PRODUCTS AFTER IMPROVEMENTS

Step No	Operation	Internal/External	Time (min)	Performed by
34	Use pipe wrench to force piston bracket over bolts.	I	1	Supervisor
35	Close hydraulic valve on formplate lifter.	I	1	Supervisor
36	Bolt new formplate lifter onto piston.	I	5	Assistant
37	Fasten vacuum pipe to formplate lifter.	I	3	Assistant
38	Open hydraulic valve on formplate lifter.	I	0.5	Supervisor
39	Remove vacuum pipe to folder.	I	0.5	Operator
40	Remove hydraulic pipe to folder.	I	0.5	Assistant
41	Push folder out from underneath offtake.	I	1	Operator
42	Undo holding nuts on folder trolley.	Redundant		Assistant
43	Remove folder from trolley.	Redundant		Operator
44	Place new folder on trolley.	Redundant		Assistant
45	Bolt new folder to trolley.	Redundant		Crane
46	Remove tape from bottom of flatsheet lifter and tape up to new profile.	I	10	Crane
47	Push folder in under offtake.	I	2	Operator
48	Replace hydraulic pipe to folder.	I	1	Assistant
49	Fasten vacuum pipe to folder.	I	3	Operator
50	Tape up folder for new size.	I	2	Assistant
51	Tape up centersheet lifter for new size.	Redundant		Supervisor
52	Set profile positions on new carriers	I	5	Supervisor
53	Loosen old cuttingframe, drop onto trolley.	I	5	Foreman
54	Open throttle valve on stamping trolley trolley runs out under wetstamp, close valve.	I	1	Operator
55	Remove cuttingframe to rack.	I	2	Operator
56	Place new cuttingframe on stamping trolley.	I	2	Assistant
57	Open throttle valve, trolley runs in under wetstamp, close valve.	I	1	Operator
58	Fasten cuttingframe to wetstamp.	I	5	Operator
59	Line up cuttingframe.	I	5	Assistant
60	Open throttle valve.	I		Operator
61	Lift production roller.	I	1	Operator
62	Undo production roller bolts.	I	1	Cutter
63	Remove roller and replace with new size	I	5	Mixer
64	Fasten roller, drop roller.	I	1	Crane
65	Prepare 2 mixes.	I	15	Cutter
66	Start machine.	I	5	Prep Operator
67	Produce first sheet.	I		Cutter
68	Set cutting depth of wetstamp.	I	3	Cutter
69	Tape up wetstamp.	I	10	Operator
70	Check profile of sheet and adjust offtake settings.	I		Supervisor
71	Start production.	I	15	Operator
	Total time involved		161.5	Foreman
	Total critical time			67.5

7.3.4 Planned improvements

The following improvements are still to be implemented:

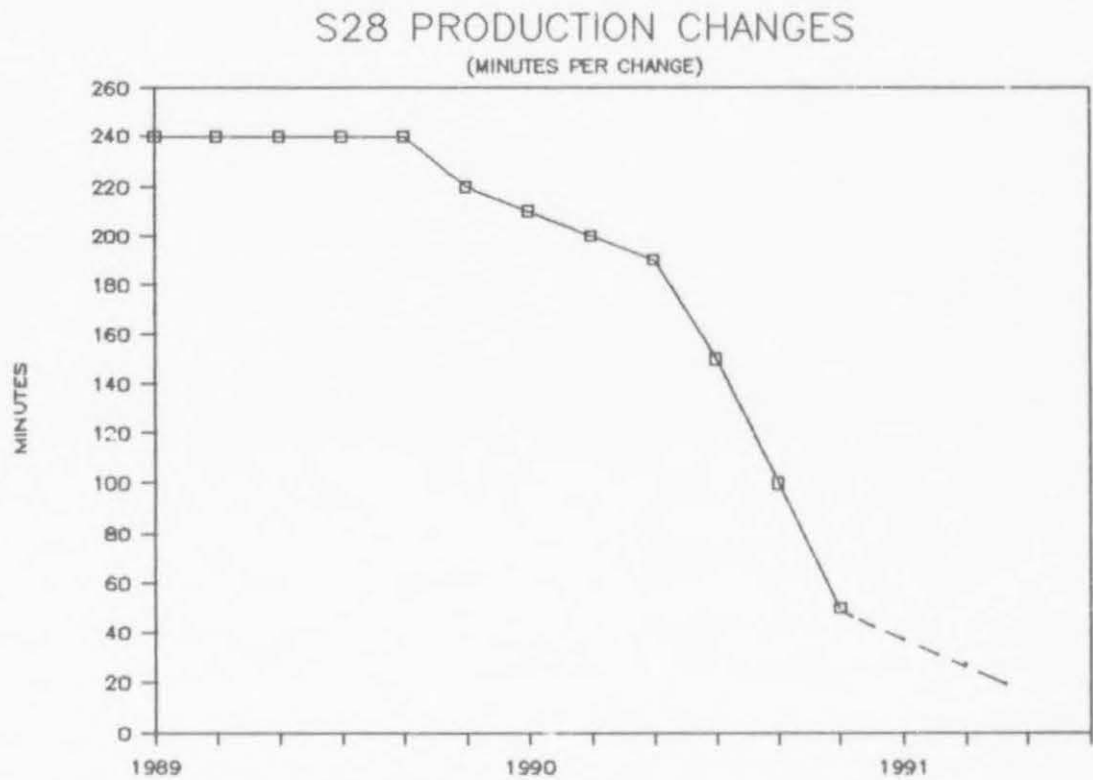
(i) Taping up the flatsheet lifter - The flatsheet lifter has to be taped up to accommodate the various products. The lifter will shortly be fitted with valves, similar to the corrugated lifters, with which these changes can be made within seconds.

(ii) Changing the lifters - This problem is discussed in section 7.3.2. The Projects Design Office is presently investigating various methods of solving this problem.

(iii) Changing the Cuttingframe - This problem and possible solutions are discussed in section 7.2.3.

The author believes that with constant practice and the implementation of these improvements, the setup time between products can easily be reduced to less than 30 minutes. This would make Just-in-Time production on S28 a very real possibility. Figure 7.8 shows the results of the Setup Time Reduction exercise to date.

Figure 7.8 SETUP TIME REDUCTION ON S28



CHAPTER 8

WORLD CLASS MANUFACTURING IN A FIBRE-CEMENT SHEET PLANT

Until recently asbestos was known as the "wonder mineral". It had characteristics which gave it a multitude of uses, many in the building and construction industries. One of the most important of these characteristics is its ability to bind with cement and form a hard, tough sheet. The FC industry used this feature to make sheets and pipes for many years. Making asbestos-cement sheets was relatively simple. Controls were few, as were rejects, and profits were high.

In the 1970's the world learnt about the negative side of asbestos. Inhalation of excessive quantities of asbestos dust, leads to asbestosis, lung cancer and other lung diseases. In Western Europe and America the production of asbestos-cement sheets and pipes was stopped. Certain companies closed down, while others decided to investigate the use of alternative fibres.

In South Africa, Everite Ltd decided to convert its plants to non-asbestos. This conversion is presently in progress and it is aimed to produce all sheets in non-asbestos (Nutech) by 1992. Nutech technology is still in its infant stages, yet it is obvious that it is not going to be easy. The technology is much more complex, requiring many more controls than asbestos-cement. Reject rates are higher and the quality of the product is lower. Strengths are

less and problems are experienced with sheets exposed to the elements. This, coupled to the rapid improvements in competition products, paints a bleak picture for the fibre-cement industry.

One of the biggest problems that the FC product has in the marketplace, is its price. In the past it used to be a relatively cheap product, used without exception for low cost housing. FC prices have now escalated to such an extent that it cannot compete with certain other products such as steel or gypsum board. Changing to Nutech is bound to raise prices even more.

In order to keep the product competitive, all forms of waste will have to be eliminated. This is one of the basic principles of World Class Manufacturing (WCM). In this chapter, the implementation of WCM in a fibre-cement sheet plant will be investigated. The various features of WCM are discussed in Chapters 2 to 5.

The author believes that the savings generated, and the improvements forced by WCM, are necessary in order to make Nutech a cost effective, quality product. This will require strong management commitment towards WCM. Only then can Nutech succeed.

Section 2.3 of this thesis deals in some detail with the theory of WCM implementation in a plant. In this section the practical application of this theory on the Sheet Plant at Everite's Brackenfell factory is discussed. Some of the features have already been implemented on S28 machine as part of a pilot project and the

results will be discussed here. Others are still outstanding, and in these cases, suggestions will be made on possible ways of implementing them.

At this stage suggestions can only be made on how to implement the pilot project. How to implement WCM in the rest of the plant will only become apparent as the pilot project is completed.

8.1 The Pre-implementation survey

The purpose of the pre-implementation survey is threefold. Its first use is to determine whether the company, or plant, is ready to start the change to WCM. Secondly, it will determine where the effort should be concentrated for the best results and, lastly, it will supply a baseline against which results can be evaluated.

Wheeler (1986) suggests that the survey should cover three main topics, namely (i) opportunities and future operating process, (ii) skills and climate assessment and (iii) organisational plan.

8.1.1 Opportunities and future operating process

The purpose of this section of the survey is to highlight those areas in which changes are required. Gathering information on the present situation in the plant allows the user to set a baseline against which to measure progress. It also gives the user the opportunity to create a vision of what the process will look like

when WCM is completely implemented. This vision is required to set a plan of action. The data required includes:

- . Inventory levels per product group.
 - Raw materials
 - Work-in-process
 - Finished goods
- . Process description at a level of detail that can be analysed for the exclusion of non-value adding elements.
- . Demand variance
- . Cost of quality and analysis of scrap.
- . Lead times (planned and actual)
- . Equipment capabilities
- . Routing categorisation if a job shop
- . Direct and indirect labour by operation
- . Purchased materials by commodity
 - Rand volume
 - Number of vendors
 - Inventory turns
- . Machine downtime by cause/symptom
- . Accounting systems requirements

The above data was collected for S28 machine and is displayed in Appendix 1. Suggestions are also given on how this information should be used to implement WCM at S28.

8.1.2 Skills and climate assessment

A skills assessment should be undertaken before WCM is implemented in a factory. Research has shown that many WCM programmes have failed or taken longer to implement than planned, due to a lack of suitably trained workers. Wheeler (1986) states that 25 - 40 percent of a section's time should be spent in WCM training and support of WCM implementation.

If a decision is taken to implement WCM in a plant such as the Sheet Plant, all of the supervisory staff will have to receive training in all of the aspects of WCM. In addition, industrial/manufacturing engineers and technicians will have to be appointed to implement WCM. All the trained staff will have to spend at least 25% of their time in WCM training and support.

A climate survey will indicate whether the atmosphere within the company is conducive to teamwork, multi-level communication, mutual trust, self-motivation and recognition. If this is not the case, Wheeler suggests that remedial action be taken before implementation of WCM commences.

Although a climate assessment was last undertaken in 1988, it is obvious that the present climate within Everite is not very conducive to change. The present political changes in South Africa have led to unrest in the townships. This atmosphere of violence and rebellion has influenced people's attitudes towards each other

and the company. The company has just been through a retrenchment exercise with a resultant ill-feeling between management and workers. In addition the present wage negotiations are heading towards a deadlock. All indications are that the situation is not going to improve within the next few years.

Management will have to make a concerted effort to improve the situation. They will have to prove that they care for their workers. This will mean giving in to demands such as paying a living wage and assisting with housing. Sacrifices will have to be made. These will include participative management and profit sharing. In short, unless management really care for their workers, and show it, they have little chance of success in implementing WCM or running a successful business.

8.1.3 Organisation/Plan

In this section of the pre-implementation survey, the organisational structure of the Implementation Steering Committee is investigated. A steering committee is required to manage the implementation and keep the momentum.

The Steering Committee should consist of management staff as well as workers. Key members should be the Regional Manager, Works Manager, QC Manager, Personnel Manager and Chairman of the Shopsteward's Committee.

The duties of the Steering Committee include:

- . Setting clear goals for WCM
- . Appointing responsible persons to perform certain tasks, such as training
- . Identify priorities
- . Resolve conflicts
- . Track progress and institute remedial action where required
- . Develop and support the manufacturing mission
- . Develop a macro-level plan for the implementation of WCM.

8.2 The Pilot Project

In the case of this thesis, S28 is the pilot project. A pilot project can only have limited success, as WCM requires company wide participation. It is important though that this success be obtained as quickly as possible and be made as visible as possible, in order to motivate management and workers to accept WCM and implement it in the rest of the company. Those aspects of WCM which can be implemented and show immediate results should thus be done first, in order to sell the idea to management and the workforce. Those specific aspects of WCM which require a great deal of time and effort and do not show immediate results should be identified and not used in the pilot project. In this way unnecessary frustration and resistance towards WCM can be avoided.

The pilot project has two functions, firstly to motivate management

and staff to accept WCM, as discussed above. The second is even more important, namely to act as a training exercise for the implementation of WCM in the rest of the plant. Mistakes made in the pilot project will not be repeated again and planning the implementation of WCM will become easier. In fact, only after implementing the pilot project should it become clear how WCM should be implemented in the rest of the plant.

8.2.1 Implementing Just-in-Time at S28

JIT is the most important building block of WCM. It is thus important that as many as possible of its features be implemented in the pilot project.

Setup time reduction - Reducing setup times at S28 has been discussed in some detail in Chapter 7. Setup times between products have been reduced by 80% while a reduction of 87,5% is anticipated in the immediate future. The author believes that reductions of up to 95% should be achieved in the long term.

This reduction in setup times makes small lot production possible. In addition it will have the following results at S28. The operation ratios or production efficiencies of the machine will improve, urgent work can be promptly undertaken and operator morale should improve.

Small lot production - As setup times have been reduced

significantly, there is no reason why production runs cannot be shortened. Production runs on S28 had always been kept to a minimum of 4 hours. With the reduced setup times, runs could be shortened to 2 hours or perhaps even 1 hour. If this was done, the full range of products could be produced in one week. This period could even be reduced to 4, 3, or 2 days as setup times are reduced further.

Production planning - At the present moment the weekly production plan is compiled by the Sheet Plant Production Planner, a member of the Sales Planning and Distribution Department. The plan is prepared a week in advance and presented to the Sheet Plant Manager on the preceding Thursday. The plan is then discussed and changed if any problems are foreseen.

The planner compiles the weekly plan by analysing the present stock figures and orders received. Management decides on an ideal stock level per product group and the planner tries to keep stocks at that level. A few problems are experienced with this system, namely:

- . Management decides on a ideal stock level by analysing present and future demand. Unfortunately this is very much of a "gut feel" decision, as future demand for products are very uncertain and a 3 week production lead time is experienced.
- . The planner only receives instruction on what the stock level per product group should be and not per size. For example, he would be instructed to have 6 weeks of Bigsix stock available, but how that should be made up is his decision. He uses his knowledge of the industry to decide what quantities of each

size to produce.

In order to solve these problems the following are suggested:

- . A scientific study should be done to determine the optimum finished stock level of every product on S28. Past sales and present building practises should be analysed to determine these levels. The study should be updated on a regular basis to compensate for improvements in the plant and changes in building methods.
- . A system of Kanbans should be introduced to keep these stock levels constant.
- . Lead times should be reduced to at least one week. This is being done at the Durban factory due to shortage of space. There is no reason why this cannot be done at Brackenfell.

The Production Planner will no longer have to compile a weekly plan, the Kanban system will ensure that the correct products are produced. He can now be used to audit the Kanban system and determine optimum stock levels per product.

Kanbans - Implementing a Kanban system at S28 should be relatively simple as the Kanbans are already available in the form of carriers and pallets.

Empty formplates are stacked onto steel carriers. These carriers are transported to the machine and the sheets produced on them. At the unpacker the sheets are either unpacked onto wooden pallets in

the case of FC or onto steel autoclave carriers in the case of SC or Nutech. After autoclaving the sheets are transferred to wooden pallets. In the finished products stockyard, the sheets are kept on the wooden pallets. Most of the sheets are also despatched on the wooden pallets. Carriers and pallets can only accommodate a fixed number of sheets due to limited crane capacity in the bay. (4 tons) Every product also has its own carriers and pallets, e.g. Bigsix cannot be made or unpacked onto Canadian Pattern carriers or pallets.

Kanban tickets can thus be fixed to the carriers and pallets. The number of Kanban tickets per product and size is then determined by the optimum stock level analysis. As sheets are despatched or committed to customers, the tickets are removed from the pallets and delivered to the shift foreman at the machine. He then produces sufficient sheets to fill the required amount of pallets. In this way the optimum stock level can be maintained.

If too many Kanbans accumulate at the machine, working overtime should be considered. If this does not solve the problem, an additional shift will have to be worked at the machine. If not enough Kanbans are returned to the machine to keep it running, cleaning and training should be done. If this does not solve the problem, a shift should be removed from the machine and used somewhere else.

Reducing inventory - A reduction in raw materials, work-in- process

and finished products inventories is one of the major savings generated by JIT. The reduction of raw material inventories in the Sheet Plant is discussed in detail in Appendix 1.

Reduction of work-in-process inventory can be achieved by reducing the number of steel carriers and formplates in the system. These carriers and formplates could be removed and necessary maintenance work performed on it. It could then be rotated with other formplates and carriers so that constant maintenance takes place on these articles.

Finished products inventory can be reduced by reducing the number of Kanbans in the system. This should only be done after a careful analysis of demand patterns.

Reducing lead times - At the present moment the planned production lead time for sheets is 3 weeks. The production lead time is defined as the time from the moment it is planned to make the sheet, until it is ready to despatch.

In theory the lead time should only be 9 to 10 days as the QC department is supposed to test the sheet for strength after 9 days. Unfortunately quality problems at handover and administrative problems often hold up testing with the result that the sheets are only available after 3 weeks.

As the Kanban system will do away with the weekly production plan,

heets will be made when required, thus reducing the lead time. The Kanban system and reduced inventories will also ensure less administrative problems, while the implementation of Total Quality Control will reduce problems with the handover to the Despatch department.

Tests have also shown that Bigsix and Canadian sheets have already matured sufficiently to pass the breaking load test after only three days. A sample sheet can thus be removed at the unpacker and not at the handover point, and sent to the QC laboratory. At the laboratory the sheet can be immersed in water after 2 days and tested after 3 days. If the test is successful the sheets can be despatched. If the sample sheet fails the test a second sample can be obtained and tested a day or two later. In this manner lead time can be reduced to 3 or 4 days.

8.2.2 Implementing Total Quality Control at S28

At the present moment the annual reject rate for S28 is $\pm 3\%$. (See figure A1.6 - Appendix 1) This unacceptably high rate will make the implementation of JIT very difficult, as explained in Chapter 3. Unfortunately many of the features which make up TQC involve training and motivating workers. Both these techniques take a long time to implement and cannot be done on a single production line. It would have to be implemented in the whole factory.

It is thus suggested that the implementation of TQC be delayed until

the pilot study is completed. As JIT requires TQC to be successful, it is suggested that the high reject rate at S28 be addressed now by eliminating the problems at the offtake. (See Appendix 2 for a report on problems experienced at the offtake.) Figure A1.7 is a Pareto diagram showing the causes of rejects, and clearly indicates that most of the rejects occur at the offtake. Addressing the causes of rejects as recommended in Appendix 2 should bring the reject rate down to 0,5%.

8.2.3 Implementing Total Worker Involvement at S28

It had been stated in section 8.1.2 that the present climate in the company was not very conducive to change. Correcting this situation cannot be implemented at one production line only, but needs to be addressed on a company wide basis. It is suggested that the techniques discussed in chapter 4 be used to facilitate the necessary change in worker attitudes.

The problem will have to be addressed immediately to prevent it worsening to such a state that no changes can be implemented within the company.

8.2.4 Implementing Total Productive Maintenance at S28

Table A1.4 (Appendix 1) shows that the breakdown availability of S28 was 96,23% for the past year, i.e. 3,77% of the available shift time was spent repairing breakdowns. This might be an acceptable percentage in traditional production management terms, but it can

lead to serious customer letdowns if JIT is implemented. It is thus suggested that TPM be implemented at S28 machine as part of the pilot project. Many of the recommendations below have already been implemented. Some concern the whole plant and not just S28.

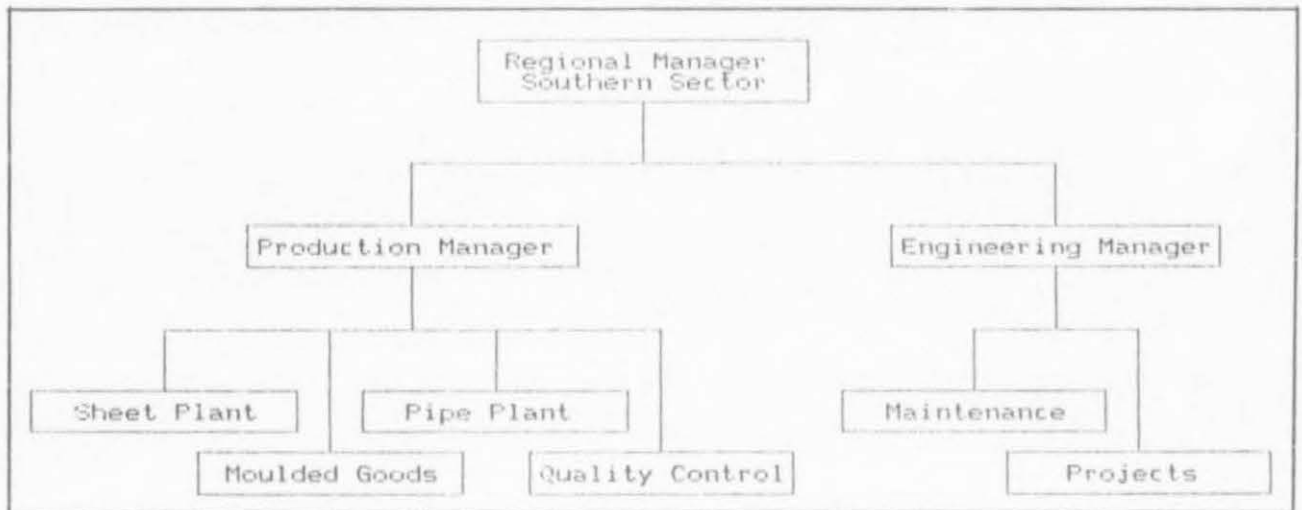
Maintenance responsibility - Traditionally maintenance personnel belonged to the Engineering Department and not Production. This has often led to the "us and them" situation with a resulting reduction of co-operation between maintenance and production personnel.

Having the maintenance personnel report to the plant managers is not a practical arrangement for two reasons: The first is that the maintenance personnel need dedicated specialist leadership which the plant manager may not always have the time or the knowledge to give. The second is that the artisans are often shared between plants due to shortages. This could only be managed by a central maintenance department.

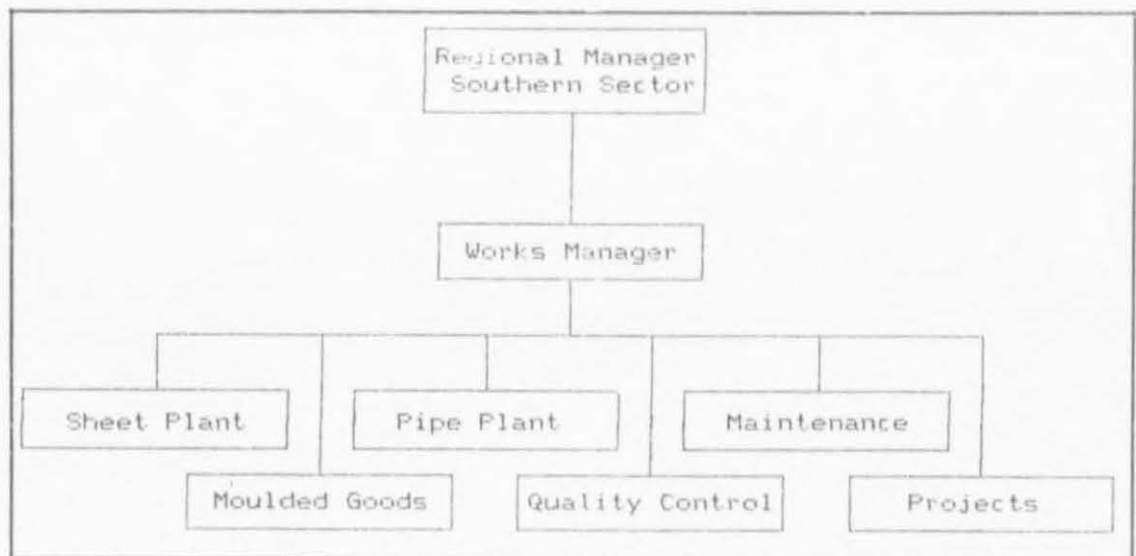
The best solution, and one which has been implemented recently, involves having the Maintenance Manager and Plant Managers report to the same person, namely a Works Manager. In this way, both parties belong to the same department. Hopefully this will improve co-operation and lead to a better service from the Maintenance Section. Figure 8.1 shows the old versus the new organisational structure.

An artisan per machine - In the past artisans used to work on any

Figure 8.1 CHANGES IN ORGANISATIONAL STRUCTURE



BEFORE



AFTER

machine as they were required. Approximately a year ago it was decided that each artisan would be assigned to a specific machine. He would be responsible for the daily inspection of the machine and perform any repairs required. Although this improved the situation, it is felt that further improvements can still be made in this regard.

A checklist should be prepared for every specific machine to assist the artisan in his inspection. The machine foreman should assist him with the inspection and repairs.

The artisan should be trained to train the production workers in basic maintenance functions such as cleaning and oiling. He should also be involved in team building exercises with the production workers to improve co-operation.

More artisans - The argument has always been put forward that maintenance should be performed at an optimum level, e.g. more artisans might improve the breakdown availability, but the saving would not be enough to warrant the additional salaries. Unfortunately a proper economic evaluation has never been done to determine if this is really the case. An economic evaluation should be done to determine what the optimum number of artisans should be and more should be employed if needed.

Preventive Maintenance - All the maintenance personnel and all the supervisory staff in the plant should receive training in the basic

principles of Preventive Maintenance and TPM. The current Preventive Maintenance procedure should then be audited and modified where necessary.

8.3 Implementing WCM

Once the pilot project has been implemented it should be evaluated to determine whether it was successful or not. Implementation of WCM in the rest of the plant can then commence. It is stated in section 2.3.3 that JIT (and WCM) should be implemented in a cyclical manner. Implementation should consist of two stages.

The first stage creates a structure in which to implement WCM. It consist of activities such as redesigning the factory layout, reducing setup times, implementing Total Quality Control and Total Preventive Maintenance. Stage 2 takes the structure created in Stage 1 and develops the process of producing only as needed, with minimum waste. It consists of such activities as training multifunction workers, forcing improvements, implementing Kanban, reducing lot sizes and reducing stock.

8.4 Evaluation

It is important to evaluate the results of the implementation on a continuous basis. These results should be compared to the baseline figures obtained in the pre-implementation survey as shown in Appendix 1. Evaluating the results will show whether implementing

the various activities have had an effect. It can also be used as an aid to motivate workers towards further improvements.

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APPENDIX 1

PRE-IMPLEMENTATION SURVEY – S28

A1.1 Inventory Levels per Product Group

In the case of S28 machine the product groups are Bigsix, Canadian Pattern and Victorian Pattern.

A1.1.1 Raw Materials

Three main types of raw material have been identified for S28, namely asbestos, cement and silica.

(i) Asbestos

Asbestos is used in all the products on S28 except Nutech Bigsix. Various grades of asbestos are blended together to give the optimum combination of strength, filtration and cost. At S28 the grades used are HVL 4, HVL5, HVL 1877 and VRA T58. The other sheet machines use the same grades of fibres, but in different ratios. The HVL fibres are from Havelock in Swaziland, while VRA T58 is from Zimbabwe.

The HVL fibres are delivered by road to the factory while the fibres from Zimbabwe are delivered by rail. The Raw Material foreman unloads the trucks and stores the bales of asbestos in the Raw Material Store. At this stage it is not possible to determine which fibres are for which machine.

The asbestos is then issued to the various machines. This is done

by using a forktruck to place the asbestos in certain demarcated areas near the machines. It is the Raw Material Foreman's duty to see that these areas always have enough asbestos for 24 hours production. What really happens is that enough asbestos is issued to every machine to keep it running for more than a week. The advantage of this is that the Raw Material Foreman only has to issue asbestos to every machine once a week. This has two disadvantages, however. The first is that the Raw Material Foreman's stock figures are not a true reflection of the actual stock available. The second is that the Production Foremen are now required to control raw material stocks, an unnecessary duplication of work.

The ordering of asbestos from the mines is done by Head Office, Technical Department. The Raw Material Foreman supplies HO with a weekly stock report. This report is used to determine when the next order should be placed. Figures A1.1 and A1.2 show the stock levels for HVL 5 and VRA T58.

The first thing that should be noticed about these graphs are that the demand for asbestos has steadily dropped over the past 5 months. This is indicated by the 1, 2 and 3 month demand lines on the graphs. The building industry is going into a recession and fewer sheets are required.

Figure A1.1 ASBESTOS INVENTORY LEVELS 1990

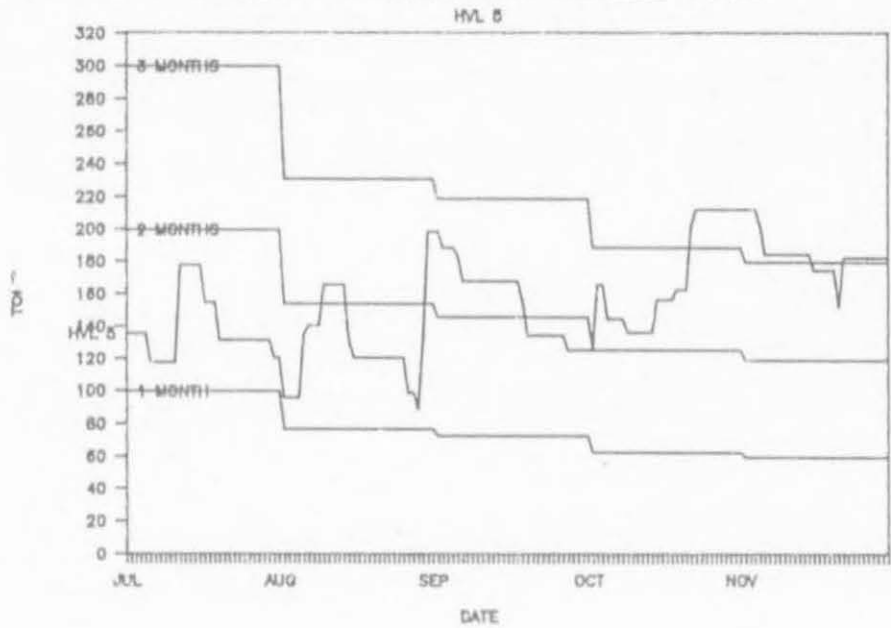
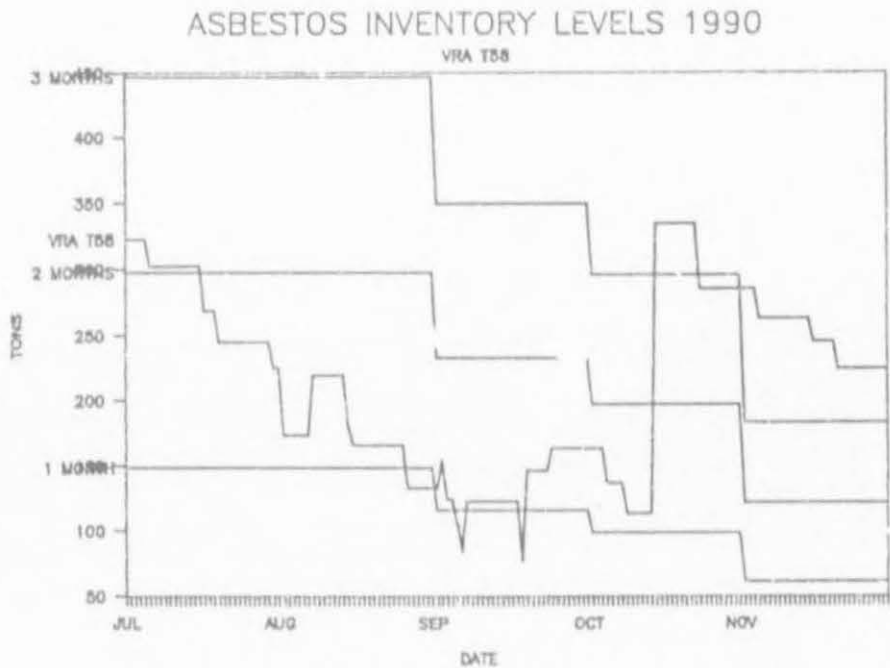


Figure A1.2



The second point to notice is the difference between the ordering pattern for HVL 5 and VRA T58. The Havelock fibres are re-ordered more often than the VRA T58. This is due to the difference in transport methods. Road transport from Swaziland is dependable and economical in small loads. Lead time is less than a week. Rail transport from Zimbabwe is not very dependable due to the shortage of rolling stock in Zimbabwe. Large stocks of VRA T58 is thus kept. Delivery often occurs in large quantities.

Suggestions

In order to control stocks of asbestos in a JIT fashion the following are suggested:

(a) The re-ordering of asbestos should be done by the factory and not Head Office. Head Office should negotiate deals with the mines and the transporting companies, but ordering should be done on a decentralised basis. The factory can monitor asbestos stocks on a continuous basis and not weekly like Head Office.

(b) Weekly or even twice weekly delivery of asbestos should be negotiated with Havelock mine and the transporting company. More frequent delivery of asbestos in mixed loads will ensure smaller stocks. In order to have a dependable supply, the demand should be communicated to the mine on a monthly basis.

(c) The Raw Material Foreman should control all of the asbestos

stocks, right up to the machine. This will eliminate unnecessary work for the Production staff and ensure more accurate control of stocks. It will also eliminate an unnecessary operation, namely placing the asbestos in a production raw material area. Asbestos should be moved from the Raw Material Store directly to the machine and should be issued to the machines at least twice a day.

(d) The need to order asbestos from Zimbabwe should be re-evaluated. An economic evaluation should be done to determine if the VRA T58 could not be replaced with a similar grade from Havalock. This will eliminate the need to keep large quantities of VRA T58 due to transport problems. There are also many advantages in having a single supplier of raw materials. This is discussed in section 2.2.5 of this thesis. One important point should be noted in this regard. Asbestos is a strategic raw material and regular contact should be kept with the management of the specific supplier to ensure a continuous supply.

(ii) Cement

Cement is supplied in bulk by PPC of Riebeeck-Wes. Jowell's transports the cement in bulk tankers from the factory to Everite in 30 ton loads. Compressed air is used to pump the cement from the tanker into S28's 120 ton storage silo. As S28 can use up to 100 tons of cement per day, the silo is refilled on a daily or twice daily basis. The Raw Material Foreman controls the ordering of cement on a daily basis.

Suggestions For all practical purposes cement is delivered in a Just-in-Time fashion.

(iii) Silica

Silica sand is mined on site and milled in the silica mill to the correct degree of fineness. The milled silica is mixed with water and pumped to the silica storage silo in the Sheet Plant. From there it is dosed into the mixes.

The sand storage bins at the silica mill can take enough sand to keep the mill running for +- 8 hours. The sand thus has to be mined on a continuous basis. The storage silo contains enough silica to keep the machines running for +- 14 hours. The mill thus also has to operate on a continuous basis.

Pockets of silica are kept in the Raw Material Store in case of breakdowns on the mill. Since a new mill has been commissioned in July, no need has been found for these emergency supplies.

Suggestions

The silica mill is already operating in a Just-in-Time mode. The emergency supplies of pocket silica should not be replaced when used. The old mill is available as a standby in case of a breakdown of the new mill. In the case of the old mill not being able to supply in an emergency, pocket silica can be bought from various

suppliers in the Cape Peninsula. Deals should be negotiated with these suppliers in advance.

A1.1.2 Work-in-Process

Two types of work-in-process can be identified at S28 machine, namely unfinished products and finished material, waiting to be approved by the QC laboratory. Table A1.1 shows the stock levels in these areas for the financial year to date.

Table A1.1 Inventory Levels S28 Machine (1000's m2v)

Product	Area	July	August	Sept	Oct
Bigsix	Production	15,2	30,6	85,2	66,9
	QC Lab	97,8	82,8	20,4	71,1
Can Pat	Production	5,8	0	0	0
	QC Lab	28,8	0	8,0	0

Unfinished material in the production area consists of:

- . material in formplates, waiting to harden
- . material waiting to be autoclaved
- . material in the autoclave
- . autoclaved material waiting to be unpacked
- . unpacked material in the handover bay, waiting to be handed over to the laboratory stockyard.

Material in the laboratory stockyard is waiting to be tested for breaking loads.

Suggestions

(a) Work-in-process inventory is obviously too large. This is not only obvious from table A1.1 but also from the physical appearance of the work-in-process stockyards. The stockyards are overcrowded, making proper control of work difficult. The situation has been made worse by the introduction of Victorian Pattern, SC Bigsix and Nutech to the product range.

It is suggested that Kanbans be used to reduce work-in-process stock. (See section 2.2.4) The formplates and carriers are already used as Kanbans. Products can not be produced unless formplates and carriers are available. By reducing the number of formplates and carriers in the system, the work-in-process will be reduced. This will require better planning and control from Production, but the results will be positive.

(b) Quicker turn-over of formplates can be achieved by heating the stacks of wet sheets. At the present moment sheets in S28 bay take 24 hours to mature enough to be unpacked. At the Durban factory, sheets are packed in steam chambers and are ready to be unpacked within 8 hours. At S25 machine Profile B sheets are heated in a tunnel and the formplates are used within 5 hours.

Heating the mudwater in the tank can also assist in shortening maturing time. Work-in-process in the maturing yard can be halved if the sheets and the mudwater are heated.

(c) Table A1.1 shows a marked increase in Bigsix work-in-process for September and October. This was caused by sheets being held back for re-inspection. Sheets are inspected at the unpacker by the operators. If they do not do this properly the QC inspector refuses to accept the sheets into the laboratory stock. The sheets then have to be re-inspected causing a hold-up and unnecessary work-in-process.

The unpacker operator and his assistants are low level employees (Peromnes grades 16 and 18) and are not trained in inspection procedures. They know the basic types of rejects and remove these, but often do not recognise the more difficult to detect rejects. It is suggested that the operators be replaced by adequately trained, grade 14 inspectors. This will ensure that no time is wasted with the handover of material to the QC laboratory.

(d) AC material handed over to the QC laboratory is tested for breaking strength 9 days after manufacturing. Tests have shown though that AC sheets can pass the breaking load test within 3 days of manufacturing. Work-in-process in the QC laboratory area can thus be reduced by two-thirds if sheets were tested after 3 days and not 9. If implementation of this procedure shows that an unacceptable number of batches do not pass the test after 3 days,

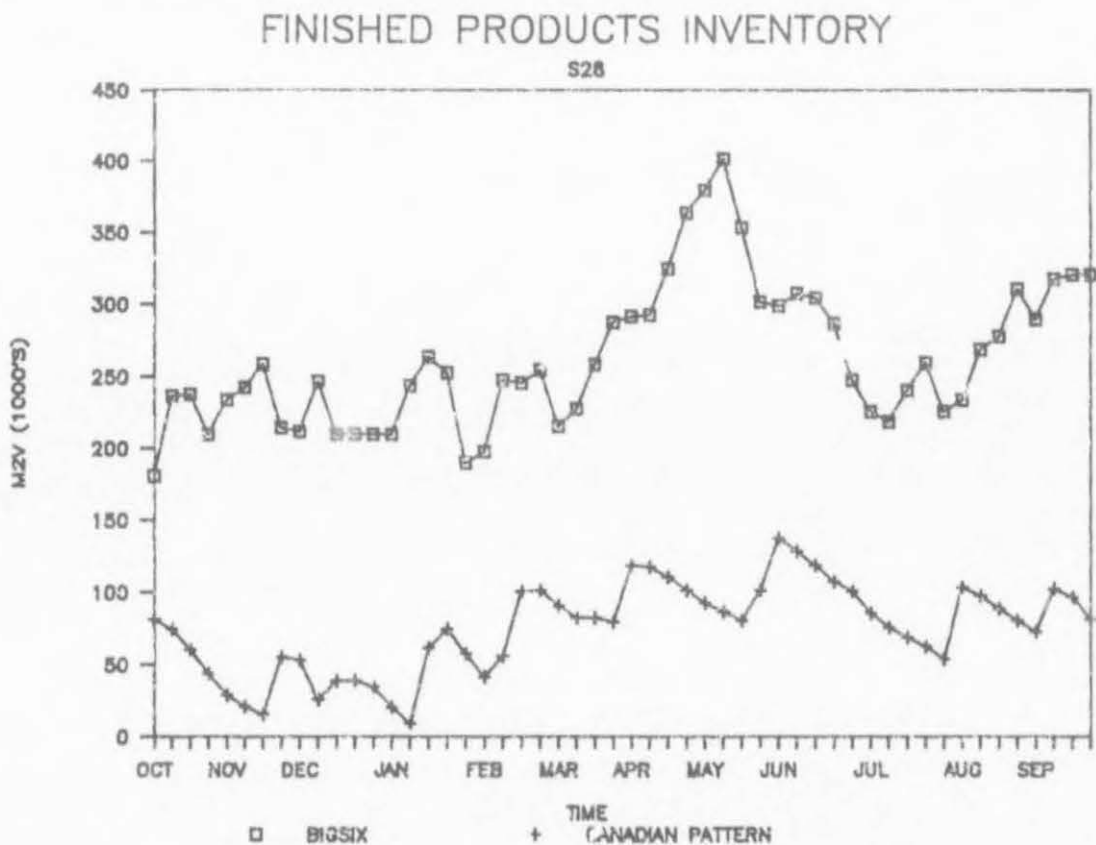
the procedure can be changed to test after 4 or 5 days.

SC sheets can be tested immediately after autoclaving and there is no reason why QC laboratory work-in-process should be more than one days production. (10 000 - 13 000 m²v)

A1.1.3 Finished Goods

Figure A1.3 shows the finished products inventory for S28 for the past 12 months. Victorian Pattern sheets are included with Bigsix. Total inventory for S28 products peaked at over 500 000m²v in May 1990. At that moment demand for products were at $\pm 60\,000\text{m}^2\text{v}$ per week. More than 8 weeks products were thus in stock.

Figure A1.3



Suggestions

(a) Reducing setup times between products, will make shorter runs of a particular product possible. (See Chapter 7) Shorter runs of a product will allow the production planner to plan the machine to produce the full range of products within one week. Less finished stock can then be kept.

(b) If the sales representatives could give more information on impending large orders, the finished stock can be reduced considerably and only increased in anticipation of specific orders. Clients should also be educated to spread their orders as they require the material and not to place large orders for delivery on a single date.

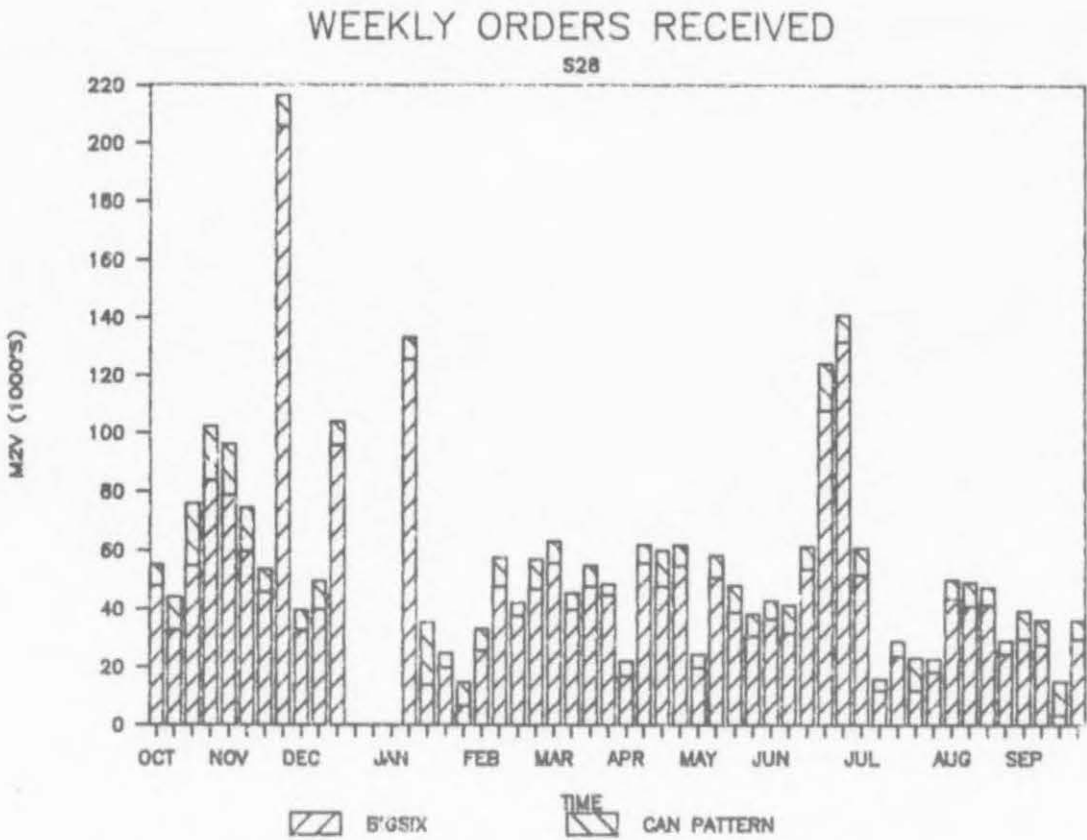
A1.2 Process description

Chapter 6 describes the process. Further information can be obtained in Appendix 3 which is an extract from the SABS 0157 procedures manual for the Sheet Plant.

A1.3 Demand variance

Figure A1.4 shows the weekly demand for products on S28 over the past 12 months. Two things should be noted about this graph.

Figure A1.4



The first is that a strong demand is always experienced before the end-of-the-year price increases. This demand also spills over into January due to the fact that orders are often placed in December for delivery in January at the old price.

The second is that the demand has steadily decreased over the past 12 months as the recession in the building industry increases. An exception was in June when large orders were received for single projects.

A1.4 Cost of quality and analysis of scrap

Determining the true cost of quality is a lengthy exercise, described in detail by Ford (1990) and others. It considers not only the cost of rejects, but also the cost of inspection, the cost of rework, the cost of disruption to process flow and the cost of preventing the rejects from occurring.

The cost of quality at S28 machine is not determined in this survey, but figures A1.5 and A1.6 show the reject rates over the past 10 years and 12 months respectively. The prime reject rate is the percentage of products that are rejected by the unpacker operators and QC inspectors. The nett reject rate is the percentage of products that are total scrap, i.e. the prime losses minus all recoveries.

Products are recovered by cutting bad parts off sheets and reclassifying them to shorter sizes. Only certain types of rejects can be recovered. E.g. if a corner of a sheet is broken the sheet can be made cut shorter, but if the sheet is too thin it has to be scrapped.

Figure A1.5 shows that the reject rate on S28 machine has steadily been increasing since 1983. A Pareto analysis of rejects over the past year (figure A1.7), shows that rejects associated with the profile, upturn and downturn are responsible for most of these rejects. In May 1990 (see figure A1.6), a prime and nett reject

rate of 6,35% was recorded. This was as a result of formplates losing their shape with continued use. Customer complaints necessitated the rejection of all deformed sheets and the reprofiling of all formplates.

Suggestions

(a) In order to implement WCM, Total Quality Control will also have to be implemented. (See Chapter 3)

(b) In the short term attention should be paid to the increasing level of rejects on S28. It is the author's opinion that continued usage without adequate maintenance has caused the offtake, carriers and formplate to deteriorate, causing increased rejects. The equipment should either be repaired to its original condition, or replaced as recommended in the project report found in Appendix 2.

Figure A1.5 S28 PRIME REJECTS



Figure A1.6 S28 REJECTS 1989/90

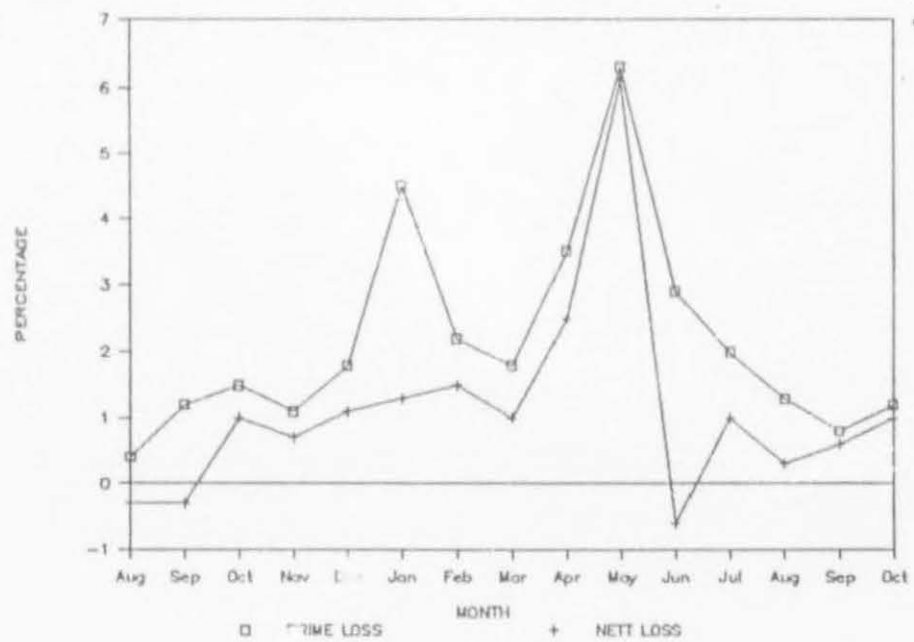
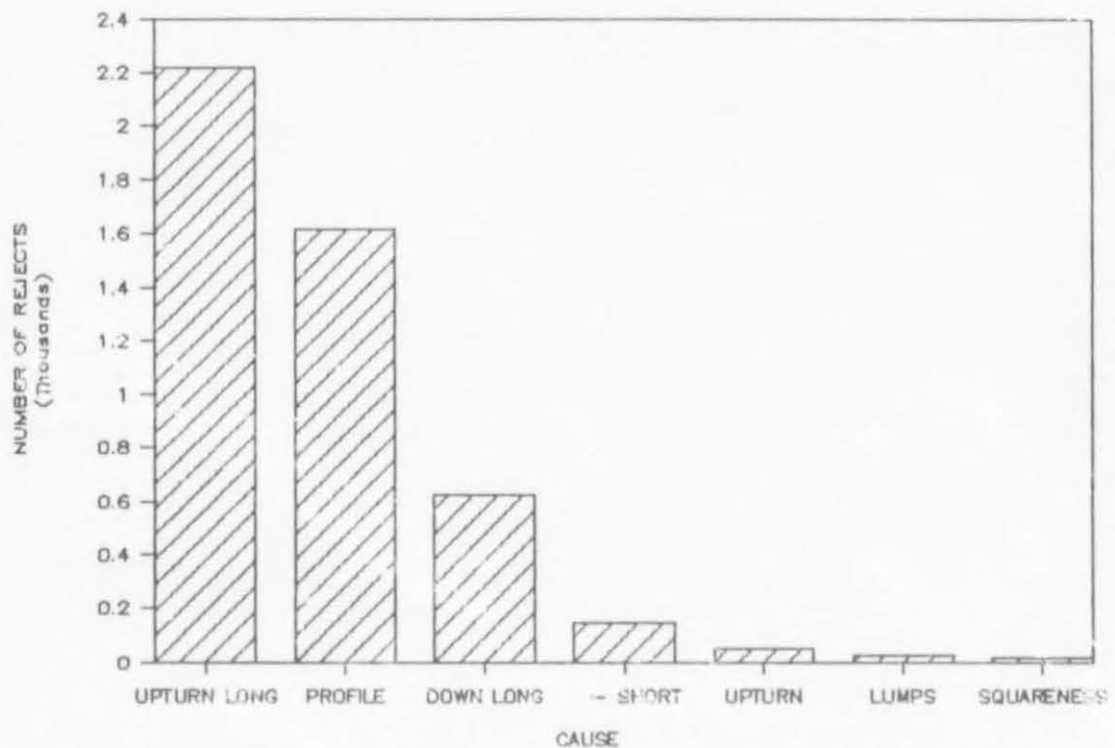


Figure A1.7 BIGSIX REJECTS 1989/90



A1.5 Lead Times

Planned lead time is three weeks from production to despatch. Actual lead may differ due to unexpected problems. At this stage no data is available on actual lead times.

Suggestions

(a) A record should be kept of actual lead times, preferably in the form of a graph, showing average weekly leadtime for the past few months.

(b) Implementing JIT will decrease lead times significantly. An

analysis of actual production time will show to what extent lead times can be reduced.

A1.6 Equipment Capabilities

Table A1.2 shows the capabilities of S28 machine. Both the unpacker and autoclaves can accommodate these outputs.

Table A1.2 S28 CAPABILITY

PRODUCT	SIZE	M2V/ SHEET	ROLLER CIRC	FELT SPEED	NUMBER LAYERS	SHEETS/ HOUR	M2V/ HOUR
BIGSIX	2.1	2.91	2.548	60	7	194	565
	2.4	3.33	2.548	60	7	194	646
	2.7	3.74	2.86	60	7	186	696
	3.0	4.16	3.163	60	7	170	707
	3.3	4.58	3.445	60	7	155	710
	3.6	4.99	3.74	60	7	140	699
CANADIAN PATTERN	2.1	3.22	2.548	60	7	194	625
	2.4	3.69	2.548	60	7	194	716
	2.7	4.15	2.86	60	7	186	772
	3.0	4.61	3.163	60	7	170	784
	3.3	5.07	3.445	60	7	155	786
	3.6	5.53	3.74	60	7	140	774
VICTORIAN PATTERN	2.7	2.70	2.86	45	6	157	425
	3.6	3.60	3.74	45	6	120	433

A1.7 Routing Categorisation

Not applicable.

A1.8 Direct and Indirect Labour

A1.8.1 Direct Labour

Required per shift: Foreman

Supervisor

Kollergang Operator

Mix Panel Operator

Mixer

Cutter

Offtake Operator

Offtake Assistant

Crane Drivers (X2)

Unpacker Operator

Unpacker Assistants (X2)

One shift works for 46 hours every week. An additional 10 hours overtime may be worked if required. Up to three shifts can be operated per week.

A1.8.2 Indirect Labour

The following indirect labour is required to work the same shift hours as the production machines, but they have to attend to more than one machine at a time.

Process Controller
Autoclave Operator
Autoclave Assistant

The following indirect labour is required to work during dayshift. These workers also supply a service to the other machines.

Plant Manager
Plant Superintendents(X2)
Production Clerk
Dayshift Foreman
Dayshift Supervisors(X2)
Plant Cleaners(X8)
Cutting Frame Repairers(X2)
Sieve Repairers(X2)
Stockyard Foreman
Stockyard Labourers(X6)
QC Inspector
Despatch Foreman
Despatch labourers

A1.9 Purchased Commodities

Table A1.3 gives a list of purchased commodities used at S28 machine. Sieves and felts are ordered by Head Office. It is felt that these are strategic commodities and as such should be controlled on a central level. Felts are manufactured in

Europe and due to the process of feltmaking, are delivered in batches of four or six.

Table A1.3 Purchased Commodities

Commodity	Supplier(s)	Rand Volumes per year	Inventory Turns
Felts	Fez	R130 000	not available
	Munsinger		
	Catala		
Sieves	Uniform	R50 000	not available
Cutting blades		R50 000	not available

A1.10 Machine downtime by cause or symptom

Table A1.4 gives this information for the past year.

A1.11 Accounting systems requirements

This information forms part of the Monthly Budget report.

Table A1.4 MACHINE DOWNTIME BY CAUSE

	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	TOTAL	TARGET
MACHINE OCCUPIED HOURS	517.33	378.00	659.89	672.00	842.00	487.00	429.00	494.77	554.51	500.27	518.00	481.83	6335.5	
PRODUCTION CHANGES - A	19.00	17.67	20.83	21.83	25.80	21.25	18.49	35.84	36.25	24.67	31.50	34.00	306.93	
ROUTINE STOPS - B	21.75	24.67	12.59	42.50	25.42	16.17	18.82	21.56	20.58	26.00	10.25	27.08	278.51	
AUTHORISED STOPS - C	27.58	17.08	23.42	20.66	47.42	24.83	13.94	6.01	9.41	36.67	44.41	26.33	298.64	
PLANT RESP. STOPS - D	32.67	9.51	35.17	34.82	44.75	6.25	16.59	13.22	23.90	17.56	28.24	11.82	276.82	
TOTAL PRODUCTION STOPS	101.00	68.93	92.01	119.81	147.19	68.50	60.02	77.55	100.14	104.92	114.40	99.33	1160.7	
PLANNED MAINT. - F	0.00	0.00	12.17	0.00	6.00	0.00	0.00	0.00	1.25	12.00	0.00	10.00	41.42	
BREAK DOWN STOPS - D	21.58	7.75	26.50	48.66	14.16	22.33	8.33	6.17	11.16	16.42	33.24	24.50	238.8	
TOTAL STOPS	122.58	76.68	130.68	168.47	167.35	90.83	75.25	81.72	112.55	133.34	147.64	133.83	1440.9	
BREAK DOWN AVAILABILITY	95.83	97.95	95.98	92.76	97.79	95.41	98.15	99.16	97.99	96.72	93.58	94.70	96.23	97.00
MECHANICAL AVAILABILITY	95.83	97.95	94.14	92.76	96.86	95.41	98.15	99.16	97.76	94.32	93.58	92.53	95.58	96.00
PRODUCTION AVAILABILITY	80.48	81.76	86.06	82.17	77.07	85.93	85.13	84.33	81.94	79.03	77.92	78.49	81.88	84.00
TOTAL AVAILABILITY	76.31	79.71	80.20	74.93	73.93	81.35	83.28	83.48	79.70	73.35	71.50	71.02	77.26	80.00
PRODUCTION EFFICIENCY	86.89	98.75	86.70	93.47	117.11	98.58	96.14	94.34	91.91	97.21	93.80	92.27	96.42	100.00
TOTAL EFFICIENCY	68.13	78.72	77.55	70.04	86.58	80.20	80.06	78.76	73.25	71.30	67.07	65.53	74.49	80.00

APPENDIX 2

30 AUGUST 1990

Investigation into S28 reject production

By S Spangenberg
A Mandix

Contents

Summary

Problem definition

Cause

Problems noted:

- 1 Cutting frame
- 2 Trolley and rails
- 3 End stop
- 4 Offtake rails and wheels
- 5 Offtake frame
- 6 Setting up procedure
- 7 Carriers
- 8 Folder

Solutions to problems noted

Recommendations

Annexure:

- 1 Carrier sizes measured and correct sizes
- 2 Rejects made during 3 months

Summary:

The machine was observed during running conditions and faults were noted. Solutions to all the faults are listed. All the faults are not to be rectified immediately, but only those in the recommendations.

A summary of rejects made in the period 30/4/90 to 23/7/90 is appended.

Problem definition:

Approximately 2% rejects are being made due to insufficient upturn and downturn on the profiles made on S 28.

Cause:

Incorrect positioning of the wet sheets between the formplates.

The task was approached by observing the machine during operation and then identifying as many as possible sources of error that could result in the wet sheet not being correctly positioned between the formplates. The problems listed are not all major problems, but each one contributes to rejects occurring due to a too short upturn or down turn on the Big 6 and Canadian Pattern profiles.

- Problems noted
- 1) Cutting frame. The sponge in this frame is of a wavy nature when replaced, and much more distorted when the cutting frame has been in use for some time. When the stamped wet sheet is sucked to the sponge the wet sheet takes up the profile of the deformed sponge, resulting in air entrapment when the sheet is dropped onto the transfer trolley. This air escapes resulting in a floating sheet which could result in the occasional misplacement of the sheet.
 - 2) Trolley and rails. The stamping trolley, transfer trolley and rails are not in a condition to be able to predict that no movement of the wet sheet relative to the trolley occurs when the sheet is transferred to the offtake.
 - 3) End stop. The end stop that stops the trolley motion is of a hard nylon material. The trolley is stopped with a sudden jolt. This has already caused an indentation into the trolley, indicating the shock applied to the trolley to stop its motion.
 - 4) Offtake rails and wheels. The offtake carriage crabs on the rails. A distinctive crabbing motion can be seen when standing on top of the offtake, resulting in jerking movements which effects the overall vibration of the offtake

frame.

- 5) Offtake frame. This frame vibrates when the cross carriage travels across it and when the up - down cylinders are operated. This results in misplacing of sheets.
- 6) Setting up procedure. During setting up of the offtake it can occur that the spacing between the individual lifters are incorrect. This causes unnecessary movement in the mixed stack.
- 7) Carriers. The carriers all seem to be different in size. (Only 19 were measured) This results in movement of the mixed stack. The carriers are also damaged underneath. The form plate profile bending can be affected by this.
- 8) Folder. The rubber on the folder stretches (ageing and fatigue) causing the profile to be out, which in turn effects the upturn on the sheets.

Solutions: 1) Cutting frames. The dowels in the cutting frames are to be replaced to ensure that there is one fixed position to which all other components are to be adjusted. This frame will then be the only locating position in the machine. All other positions after this are then adjustable.

The waviness in the foam can be rectified by having a rigid backing to the foam. An expanded metal sheet would be ideally suited for this. The suitable range applicable for this is LWM = 20 - 40 mm and SMW = 8 - 15 mm. The expanded metal can be welded or bolted into position. It is suggested that one cutting frame be done, to ensure that this does not interfere with any production requirement, before all the other cutting frames are modified. Returning to just a metal grid without the foam is another option, but as was pointed out, it may mark the wet sheet during the production process.

- 2) Trolley and rails. These components are on the regular maintenance program at maintenance for replacement. This replacement is planned for the X-mas shut down. This schedule should perhaps be adjusted to replace components after a certain number of operations, rather than on a time basis.
- 3) End stop. A different end stop need not be designed. The only change required, is a rubber stopper to replace the present nylon stopper. This will result in a much smoother stopping action than presently.

- 4) Offtake rails and wheels. This requires major revamping on the machine and it is not felt that this is a major contributor to the irregular alignment of the wet sheet between the formplates.
- 5) Offtake frame. The vibrations felt when standing on top of the offtake during operation are not considered to have major influence on the wet sheet positioning. The structure can be regouted and new holding down bolts inserted.
- 6) Setting up procedure. This has a major influence on the upturn of the sheets produced. Bad setting up of the formplate lifter or corrugated sheet lifter causes movement in the the corrugated sheet to stick to the lifter and then flopping down. This can be noticed when making the longer sheets (eg two 1.8m sheets). A setting up procedure should be compiled and adhered to so that this error cannot be incurred when production changes are made.
- 7) Carrier. The carrier drawings were obtained and it was found that the carriers are to be manufactured with a jig so that this kind of error is not possible. The biggest error is on the sides of the carriers (only E6 measured). The problem are the guides on the machine where the carriers are placed. These guides position the carrier in one position, while the machine's lifters then move the carrier to the central position between two lifters. The guide for the initial positioning of the carrier by the crane sometimes obstructs this locating method. This can easily be rectified by changing the guides to allow for more movement. The more serious dimension inaccuracy is the spacing between the profile bumps. These influence the life of the formplates and also the shape of the wet sheet inbetween. The bottom of many carriers are also badly damaged which in turn damages the formplates. This is also a contributor to the bowing of the formplates. It is suggested that a wooding out process is started to reduce the high stress on the formplates.
- 8) Folder. The folding mechanism must be checked for structural damage, functionality and stretched rubber before any production commences. This can be incorporated into the setting up procedure. The rubber gets replaced at regular intervals, but should actually be changed after a fixed number of operations.

Recommendations

- 1 Install hard backing to the cutting frames. (eg expanded metal)
- 2 Replace dowels in cutting frame with rubber stop.
- 3 Replace nylon stopper.
- 4 Draw up a comprehensive procedure to be followed for production changes.
- 5 Begin replacement of carriers.

After recommendations 1 to 4 are implemented and the rails and trolleys have been replaced, the reject rate of S28 can be roaddressed for further improvements.

ANNEXURE

1 Measures taken of carriers

Measurements on the B6 carriers on the south side, as positioned in the plant, were taken:

First eleven short carriers were measured and then eight long carriers.

Carrier no	mm	mm	mm	mm	mm	mm	mm
The correct dimensions according to drg no. M2-1086A are:	181.5	177	177	177	177	177	181.5
Measured dimension are:							
7	183	178	175	176	173	175	
98	190	177	174	176	179	185	
n/a	189	176	176	176	179	175	
8	188	178	173	178	179	175	
91	188	177	177	177	178	177	
82	190	175	176	175	178	171	
114	188	177	175	174	179	175	
39	190	176	175	177	178	175	
60	187	176	176	175	180	168	
24	190	179	175	177	179	164	
84	185	176	175	176	178	177	
121	184	175	173	175	181	173	
30	181	176	177	178	175	178	
48	191	172	180	175	179	174	
108	176	177	175	176	177	177	
109	178	177	175	176	179	109	
99	182	175	177	177	175	180	
104	182	176	177	175	176	181	
105	178	177	176	176	176	181	
104	182	176	177	175	176	181	


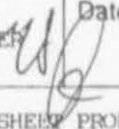
3 months rejects


Summary of corrugated sheets rejected by QC from 30/4/90 until 23/7/90.

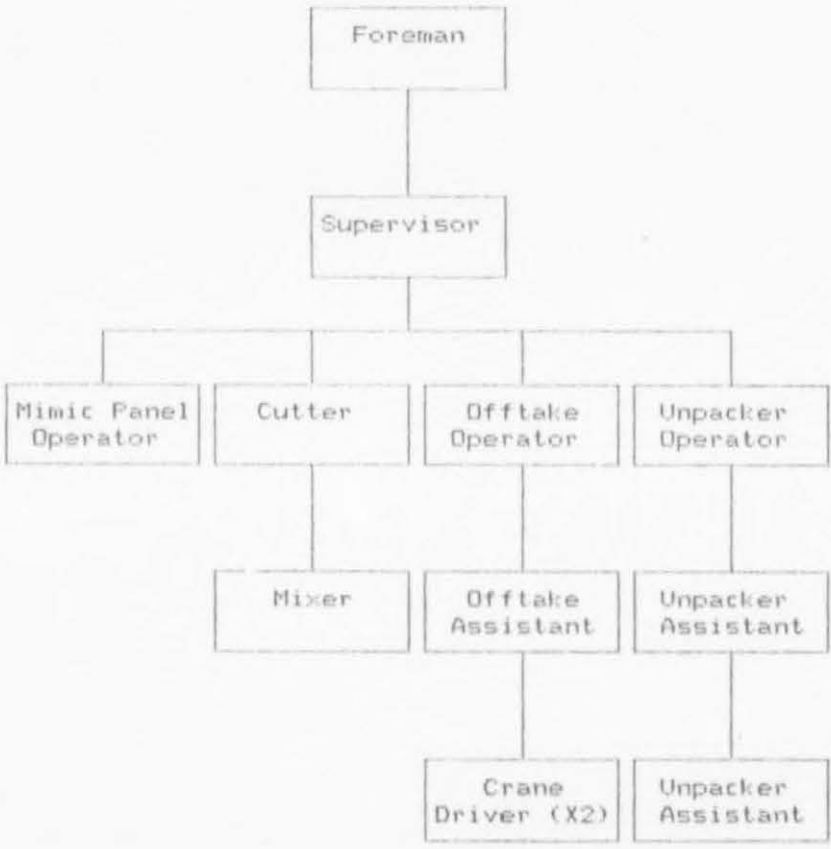
I	length	I	Qty inspec	I	total reject	I	down/ upturn	I	%	I
I	1.8	I	11 710	I	2 716	I	1 484	I	12.7	I
I	2.1	I	20 756	I	708	I	668	I	3.2	I
I	2.4	I	19 023	I	719	I	344	I	1.8	I
I	2.7	I	17 968	I	364	I	345	I	1.9	I
I	3.0	I	29 332	I	644	I	585	I	2.0	I
I	3.3	I	22 500	I	530	I	339	I	1.5	I
I	3.6	I	21 459	I	1 195	I	726	I	3.7	I

APPENDIX 3

EXTRACT FROM SHEET PLANT PROCEDURES AND
WORK INSTRUCTIONS MANUAL - SABS 0157

 EVERITE	BRACKENFELL : SHEET PLANT PROCEDURES AND WORK INSTRUCTIONS		
	MANUAL		
S 28	SUB-INDEX	SABS 0157 REF.	SECTION F.2.8.1
F.2.8.1 SUB-INDEX F.2.8.2 ORGANISATIONAL STRUCTURE F.2.8.3 PROCESS FLOW CHART F.2.8.4 MIX PREPARATION F.2.8.5 MACHINE DESCRIPTION F.2.8.6 SHEET PRODUCTION F.2.8.7 MOULDED GOODS WET SHEET PRODUCTION F.2.8.8 UNPACKING OF MATURED SHEETS F.2.8.9 OVERHEAD CRANE OPERATION F.2.8.10 CALIBRATION OF EQUIPMENT F.2.8.11 PROCESS CONTROL STANDARDS			
Prepared by PRODUCTION ENGINEER 		Date Issued JANUARY 1990	Revision Status ORIGINAL
Approved by : MANAGER SHEET PRODUCTION		Page No : 1 of 1	

 EVERITE	BRACKENFELL : SHEET PLANT PROCEDURES AND WORK INSTRUCTIONS MANUAL		
	ORGANISATIONAL STRUCTURE S 28	SABS 0157 REF. 4.1.2	SECTION F.2.8.2



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graph TD
    Foreman[Foreman] --> Supervisor[Supervisor]
    Supervisor --> Mimic[Mimic Panel Operator]
    Supervisor --> Cutter[Cutter]
    Supervisor --> Offtake[Offtake Operator]
    Supervisor --> Unpacker[Unpacker Operator]
    Cutter --> Mixer[Mixer]
    Offtake --> OfftakeAss[Offtake Assistant]
    Unpacker --> UnpackerAss[Unpacker Assistant]
    OfftakeAss --> Crane[Crane Driver (X2)]
    UnpackerAss --> UnpackerAss2[Unpacker Assistant]
      
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S 28 PROCESS FLOW CHART

SABS 0157
REF. 4.8.1SECTION
F.2.8.3REFERENCE




1. Bags or asbestos in store
2. Roller asbestos
3. Take water content sample
4. Transport with Redler conveyer
5. Fiberise Asbestos
6. Silica reserves in veld
7. Mine silica sand
8. Transport to mill
9. Mill sand
10. Determine blaine and solids
11. Pump silica to plant
12. Storage
13. Feed in rigline
14. Weigh off silica
15. Cellulose in store
16. Pulp cellulose
17. Check cellulose solids
18. Refine cellulose
19. Check SR of cellulose
20. Weigh off cellulose
21. Cement in storage tank
22. Check cement blaire
23. Screw conveyer
24. Weigh of cement


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S 28 PROCESS FLOW CHART		SABS 0157 REF. 4.8.1	SECTION F.2.8.3
25. Mudwater tank 26. Crush reject sheets and pipes 27. Crusch material in silo 28. Mix with water 29. Store in the stirrer 30. Pump to machine 31. Weigh of wetwaste 32. Dissolve MG offcuts 33. Pump to Sheet Plant 34. Store in PE stirrer 35. Pump in rigline 37. Weigh of wetwaste 38. Mixer 39. Store in stirrer 40. Produce a sheet 41. Visually examine sheet 42. Stock sheets at offtake 43. Load MG sheets on trolleys 44. Moulded Goods 45. Sheet mature 46. Unpack sheets 47. Inspect sheets at unpocker 48. Autoclave sheets 49. Mature			
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	S 28 PROCESS FLOW CHART	REF. 4.8.1	F.2.8.3
<p>50. Inspect sheets</p> <p>51. Store in stockyard</p> <p>52. Lab sample</p> <p>53. Hard sheet cutting</p> <p>54. Sheet coating</p> <p>55. Despatch sheets</p>			
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	S 28 MIX PREPARATION	SABS 0157 REF. 4.8.1	SECTION F.2.8.4

FUNCTION: To ensure that sufficient quantities of raw materials are mixed for S 28 machine.

USERS: Shift Foreman, Mimic Panel Operator, Supervisor

ACCOUNT-ABILITY: Shift Foreman

CONTENTS:

1. Description.
2. Startup.
3. Shutdown.
4. Quality.
5. Safety.

1. Description of Plant (Refer to Annexure 1)

S 28 mix preparation plant is completely automated and only requires human intervention for startup, shutdown and breakdowns. The plant is controlled by a process control computer and a mimic panel. The computer is situated in the Clerk's office and the mimic panel at the rear of the preparation plant. All setpoints are made on the computer.

- 1.1 Kollered asbestos is stored in an accumulator from where a Redler conveyor transports it to a fibre weigh bin.
- 1.2 The fibre weigh bin is fitted with a loadcell and this stops the conveyor when a certain amount of asbestos is weighed off.
- 1.3 The fibre weigh bin discharge door opens and drops the asbestos into the fiberiser where it is spun. If cellulose is required in the mix, it is added.
- 1.4 The fiberiser valve opens after spinning, allowing the fibres into the HRB mixer.
- 1.5 Hardwaste and wetwaste is weighed off in the waste weigh bin and added to the HRB mixer.
- 1.6 Silica is weighed off in the silica weigh bin and added if required.
- 1.7 Finally the cement is weighed off and charged into the HRB mixer.
- 1.8 This mixture is mixed for 3 minutes and then discharged into the stirrer.
- 1.9 As soon as the stirrer level drops sufficiently, the cycle is repeated.

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	S 28 MIX PREPARATION	SABS 0157 REF. 4.8.1	SECTION F.2.8.4

4.1 Fiberiser

The function of the fiberiser is to open the crushed and rolled up fibre bundles, ie: to fiberise the asbestos. Fiberised asbestos must still show fibres and must not be a jelly. Visually examine the fibres at least once a day.

Impellor blades must be square as smooth or rounded off blades cause a loss of effectiveness of the fiberiser.

Fiberiser time is set on the prep plant MCC and must be a minimum of 3 minutes.

The second stage of the two stage motor must be reached to ensure proper fiberising.

It is important that the fiberiser is completely drained to ensure that correct fibre addition to the Hollander is achieved. It is also important that the fiberiser is washed off all fibre before the next charge is prepared.

4.2 Water, cellulose/silica, cement and fibre weighing vessels

It is important that these vessels are kept clean and a build-up inside prevented. A build-up of hard material could cause inaccurate weighing and could cause waste lumps on the sheet when it breaks loose.

4.3 HRB Mixer

The HRB mixer serves as the mixing vessel where cellulose, silica and water are mixed.

Regularly clean the cement rubber to prevent waste lumps forming. These lumps break off and cause poor quality sheets. The lumps may also cause the rubber to block, leading to a breakdown.



4.4 Stirrer

The stirrer has three functions, namely:-

- It is an intermediate storage vessel.
- A certain amount of mixing takes place.
- It feeds the mix to the machine.

The stirrer must be kept clean at all times to prevent a build-up and waste lumps on the sheet. This is done by washing the sides down every hour.

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	S 26 MIX PREPARATION	SABS 0157 REF. 4.8.1	SECTION F.2.8.4
<p>The feed buckets and launder tray must be scraped and cleaned regularly to ensure a proper feed to the machine.</p> <p>Regular checks must be made to ensure that it has mix in to prevent sheets being made from wet waste or mudwater.</p> <p>The stirrer must run at a constant speed and no separation of mix and water must occur.</p>			
<p>5. <u>Safety</u></p> <p>5.1 Clean up all spillages in and around the preparation plant as these can cause accidents.</p> <p>5.2 Never allow anybody to work on or in a machine without locking out the power supply at the DB board. A sudden power dip or an unauthorised person working the computer may cause equipment to start without warning.</p>			
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 EVERITE <small>Form Control Manufacturing</small>	BRACKENFELL : SHEET PLANT PROCEDURES AND WORK INSTRUCTIONS		
	MANUAL		
	S 28 MACHINE DESCRIPTION	SABS 0157 REF. 4.8.1	SECTION F.2.8.5
<p><u>FUNCTION:</u> To ensure that a thorough understanding of S 28 machine is gained, so that sheets of the required quality are produced safely and efficiently.</p> <p><u>USERS:</u> Shift Foreman S 28, Shift Supervisor S 28, Cutter, Mixer</p> <p><u>ACCOUNT-ABILITY:</u> Shift Foreman</p> <p><u>CONTENTS:</u></p> <ol style="list-style-type: none"> 1. Machine description 2. Start up procedure 3. Shutdown procedure 4. Cleaning and maintenance <p>1. <u>Description:</u> Refer to drawing in Annexure 1)</p> <p>For the purpose of this procedure, S 28 dewatering machine is defined as all parts between and including the mixbox and production roller.</p> <p>1.1 <u>Mixbox</u></p> <p>The purpose of the mixbox is to supply each of the 3 machine vats with a steady supply of mix and dilution water at a certain density. The denser the mix, the thicker the layer that forms on the felt.</p> <p>The mixbox consists of a steel vessel fitted with an agitator to supply the mixing effect. A nuclear densometer in the box reflects the density of the mix. This density is compared to the specified density inputted at the machine control table. If the density is too high, a pneumatically controlled valve, opens and allows more dilution water into the mixbox. If the density is too low, the valve closes and less dilution water is fed into the box. The densometer thus continuously monitors the density of the mix and adjusts the dilution water feed rate to compensate.</p> <p>The amount of mix in the mixbox is controlled by a pneumatically controlled valve in the launder from the stirrer to the mixbox.</p> <p>At the outlet side of the mixbox 3 pneumatically controlled spade valve controls the flow of diluted mix to the machine vats. The main purpose of these valves is to control the level of the vats. When a valve opens, more mix flows through the launder into the vat and its level rises and vice versa. A bubbler tube in each vat determines its mix level. This mix level is compared to the set-point at the control table and the valve is opened or closed as required.</p>			
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S 28 MACHINE DESCRIPTION		SABS 0157 REF. 4-8.1	SECTION P.2.8.5

1.2 Vats and Sieves

The vats are hollow vessels in which the sieves rotate and pick up mix to deposit on the felt. Mix enters the vats through launders from the mixbox. Solids in the mix are carried onto the felt by the sieves while water is filtered through the sieves and out through the openings in the sump. Mix is prevented from flowing to the centre of the sieve by rubber sieve bands.

Each vat is fitted with two agitators to prevent the mix from building up inside the vat.

1.3 Felt

The purpose of the felt is threefold. Firstly it transports mix from the sieves to the production roller. Secondly it supplies a medium through which water can be sucked to dry the sheet and lastly it transmits power from the breast roller to the sieves and rollers to make them turn.

The felt is normally made from woven polyester fibres which make it both porous and strong.

The felt is kept tight by adjusting the tensioning roller and is aligned by the felt adjustment roller.

1.4 Couch Rollers

The couch rollers wrap the felt around a certain area of the sieve to allow proper pickup of mix. This also allows sufficient friction area to drive the sieve. The couch roller also squeezes a certain amount of water out of the felt and mix.




1.5 Vorsaugers, vacuum boxes and vacuum pumps


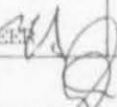
The purpose of the various boxes is to dry the felt and the layer on it. The 2 vorsaugers are on the bottom part of the felt, before sieve No 2 and sieve No 3 and the vacuum boxes are on the top section of the felt.


Vorsaugers ("front-suckers") are hollow boxes with only one slot while vacuum boxes have more than one slot for better distribution of vacuum.

The vacuum pumps supply the vacuum for the boxes while the silencer allows all the water sucked out of the layer on the felt to be returned to the machine sump.

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S-28 MACHINE DESCRIPTION		SABS 0157 REF: 4.8.1	SECTION F.2.8.5								
<p>Connection of the various boxes and pumps on S 25 are as follows:-</p> <table border="1"> <tr> <td>Vacuum pump No 1</td> <td>Premain, Vorsauger No 2</td> </tr> <tr> <td>Vacuum pump No 2</td> <td>Vorsauger No 1</td> </tr> <tr> <td>Vacuum pump No 3</td> <td>Washbox</td> </tr> <tr> <td>Vacuum pump No 4</td> <td>Main vacuum box</td> </tr> </table>				Vacuum pump No 1	Premain, Vorsauger No 2	Vacuum pump No 2	Vorsauger No 1	Vacuum pump No 3	Washbox	Vacuum pump No 4	Main vacuum box
Vacuum pump No 1	Premain, Vorsauger No 2										
Vacuum pump No 2	Vorsauger No 1										
Vacuum pump No 3	Washbox										
Vacuum pump No 4	Main vacuum box										
<p>1.6 <u>Sieve washing system</u> (See Annexure 1)</p> <p>Clean system water is drawn from the top of the mudwater tank by the spray water pump. This water is then used to wash the sieves using spray pipes. The spray pipes oscilate so that the whole sieve is washed.</p>											
<p>1.7 <u>Spiral roller</u></p> <p>The spiral roller spreads the felt so that it does not block.</p>											
<p>1.8 <u>Idler rollers</u></p> <p>These rollers guide the felt across the machine.</p>											
<p>1.9 <u>Breast roller</u></p> <p>The breast roller dewateres the layer on the production roller and also supplies the drive to the felt. In the case of S 28 a grooved breast roller may be fitted to assist in dewatering.</p>											
<p>1.10 <u>Production roller</u></p> <p>The sheet gets formed on the production roller by successive layers of mix. Once the required thickness is achieved, the sheet gets cut off the roller by a cam operated cutting wire. The production roller is pressed onto the breast roller by two pneumatic cylinders. This gives the sheet a certain density. In the cutting groove, this density is much lower and this allows the sheet to be cut in that position.</p>											
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<p>S 28 has six sizes of production roller namely 2,1; 2,4; 2,7; 3; 3,3; and 3,6. This allows sheets of between 1,8 and 3,6 m to be made.</p> <p>Production rollers have an outer shell of either grinded steel or ceramic coated steel. Once the surface is no longer smooth or circular, pickup will become impossible. The shell then has to be grinded and re-coated.</p>			
<p>1.11 <u>Sump and mudwater pump</u></p> <p>All the water filtered into the centre of the sieves as well as felt washing water, spillages and the exhaust from the vacuum pump silencer, flows into the mudwater sump. This water is pumped by the mudwater pump to the top of the mudwater tank.</p>			
<p>1.12 <u>Mudwater tank</u> (See Annexure 3)</p> <p>The mudwater tank has two functions, namely to act as a buffer supply of water for the machine and to filter the mudwater into clean spray water and dirty dilution water. This is achieved by letting solids in the water settle down to the bottom of the tank and clean water rise to the top.</p> <p>A set of sprayers, supplied by a mono pump, breaks down any foam which may accumulate at the top of the tank and block the overflow outlet.</p> <p>The mudwater tank must be drained and cleaned once per week to prevent blockages.</p>			
<p>2. <u>Start Up</u></p> <p>Assuming:</p> <ol style="list-style-type: none"> 1. Machine is off. 2. Mudwater tank is full. 3. Kollered fibre is available. 4. Setpoints at control panel are correct. <ol style="list-style-type: none"> 1. Open valve - water supply from dam. 2. Switch on pump of mudwater tank. 3. Close stirrer valve at main drive panel. 4. Release main drive emergency stop. 5. Press start button - maximum speed 16 rpm. 6. Open water valve of spray pipes and start pump. 			
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S-28 MACHINE DESCRIPTION		SABS 0157 REF. 4.8.1	SECTION F.2.8.5
<ol style="list-style-type: none"> 7. Switch on agitators, rocking device and vacuum pumps at distribution board. 8. Clean probes of vats and mixbox. 9. Close vats drain plugs. 10. Close mixbox outlet valve. 11. Start mixbox agitator. 12. Open water valve at mudwater tank. 13. Open valve from mudwater tank to mixbox. 14. Open stirrer valve. 			
<p>3. <u>Shutdown</u></p> <ol style="list-style-type: none"> 1. Close stirrer valve. 2. Reduce speed of production roller to 12 - 16 rpm. 3. Open vat drain plugs. 4. Open mixbox valve and drain balance of mix. 5. Open stirrer valve. 6. Wash mixbox. 7. Wash sieves, splashboards, machine and sump. 8. Clean all spray pipes. 9. Switch off agitators, rocking device and vacuums at distribution board. 10. Switch off mixbox agitator. 11. Close water valve of spray pipes and switch off pump. 12. Cut sheet on production roller. 13. Stop production roller at panel - Press emergency switch. 14. Close water valve from dam. 15. Switch off mudwater pump. 			
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REF. 4.8.1

F.2.8.5

4. Cleaning and Maintenance

A clean and well maintained machine leads to better quality, higher efficiency and safer and more pleasant working environment. Housekeeping should be at 5-star standard.

Although the maintenance of the machine is the responsibility of the Engineering Department, Production have certain functions to perform. Paying attention to detail will also assist the Maintenance personnel in their work.

4.1 Mixbox

FUNCTION	PERIOD
1. Check agitator seals for leaks.	Daily
2. Check agitator amps against ideal.	Daily
3. Check level in mixbox.	Hourly
4. Wash off spillages and foam.	Continuously
5. Wash out inside of mixbox.	Weekly
6. Clean spade valve and valve guides.	Weekly
7. Check condition of all airlines.	Weekly
8. Scrape outside and paint.	Annually

4.2 Sump

FUNCTION	PERIOD
1. Check sump for build-up.	Weekly
2. Wash down sump with hose.	Hourly
3. Jackhammer sump to original depth.	Planned Maintenance

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S 28 MACHINE DESCRIPTION

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4.3 Vats

FUNCTION	PERIOD
1. Check vats for build-up and clean.	Weekly shut-down or when uneven sheets are produced.
2. Check agitator seals for leaks.	Daily
3. Clean splashboards.	Hourly
4. Clean spray pipes.	Hourly
5. Check agitator blades for wear or cracks.	Weekly shut-down

4.4 Sieves

FUNCTION	PERIOD
1. Check sieve seals for leaks.	Daily
2. Clean sieve spray pipes.	Hourly
3. Check felt for black streaks indicating blocked sieves.	Continuously
4. Check tension of sieve screen (hit with palm of hand and listen to ring).	Weekly shut-down

4.5 Vacuum boxes and pumps

FUNCTION	PERIOD
1. Clean boxes (insides and slots).	Weekly shut-down.
2. Inspect box tops for sharp edges which may damage felt.	Weekly shut-down.
3. Check box tops for wear and replace if needed.	Weekly shut-down.
4. Clean vacuum pipes, exhaust pipes and silencer.	Planned Maintenance
5. Check gland water to pumps.	Daily

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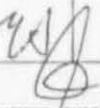

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		SECTION P.2.8.5										
<p>4.6 <u>Rollers</u></p> <table border="1"> <thead> <tr> <th>FUNCTION</th> <th>PERIOD</th> </tr> </thead> <tbody> <tr> <td>1. Clean all rollers.</td> <td>Continuously</td> </tr> <tr> <td>2. Check condition of rollers and replace if pitted or sharp edges.</td> <td>Weekly shut-down</td> </tr> <tr> <td>3. Check straightness of couch and breast rollers and replace if deviation more than 1 mm.</td> <td>Weekly shut-down</td> </tr> <tr> <td>4. Align all rollers and sieves with breast roller.</td> <td>Planned Maintenance</td> </tr> </tbody> </table>			FUNCTION	PERIOD	1. Clean all rollers.	Continuously	2. Check condition of rollers and replace if pitted or sharp edges.	Weekly shut-down	3. Check straightness of couch and breast rollers and replace if deviation more than 1 mm.	Weekly shut-down	4. Align all rollers and sieves with breast roller.	Planned Maintenance
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<p>4.7 <u>Felt</u></p> <table border="1"> <thead> <tr> <th>FUNCTION</th> <th>PERIOD</th> </tr> </thead> <tbody> <tr> <td>1. Clean felt spray pipes.</td> <td>Hourly</td> </tr> <tr> <td>2. Ensure manufacturer's line on felt is straight.</td> <td>Continuously</td> </tr> <tr> <td>3. Check and adjust tension of felt.</td> <td>Continuously</td> </tr> </tbody> </table>			FUNCTION	PERIOD	1. Clean felt spray pipes.	Hourly	2. Ensure manufacturer's line on felt is straight.	Continuously	3. Check and adjust tension of felt.	Continuously		
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F.2.8.6			
<u>FUNCTION:</u>	To produce a sheet of a specific length, thickness and quality standard.		
<u>USERS:</u>	Shift Foreman, Supervisor, Cutter, Offtake Operators		
<u>ACCOUNT- ABILITY:</u>	Shift Foreman		
<u>CONTENTS:</u>	1. Forming and cutting a sheet from the production roller. 2. Operating the offtake and wet stamp. 3. Changing production size. 4. Safety. 5. Quality.		
1.	<u>Forming and Cutting a Sheet from Production Roller</u>		
	This procedure assumes that the mix is transferring from the felt onto the production roller and that the cutting frame, SABS batch and date stamp are correct.		
1.1	The Cutter is given the thickness of the sheet by the Foreman.		
1.2	The thickness is measured by a thickness gauge set at the non-drive side of the production roller beam.		
1.3	At the correct thickness, the Cutter activates the cutting mechanism and the sheet is released from the production roller.		
1.4	The sheet travels on conveyor No 1 and is stopped by a limit switch.		
1.5	Every 10th sheet is checked by the Cutter for thickness.		
1.6	A visual and "feel" quality test is also carried out.		
1.7	The sheet is then taken to the wet stamp by the Offtake Operator.		
2.	<u>Operating the Wet Stamp</u>		
2.1	<u>Startup</u>		
	- Start the wet stamp high pressure system as indicated on the board against the oil tank. Be carefull to follow these instructions carefully as incorrect startup could cause the safety valve to blow and pressure to be lost.		
	- Put the offtake main power switch (against side of offtake control panel) on.		
	- Start the corrugated folder vacuum pump (the switch is on the panel).		
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<ul style="list-style-type: none"> - Start the sheet/formplate lifter vacuum pump. - Change the mode switch to auto. - Press the start button. - If any problems occur, change the mode switch to manual and correct the problem. Change mode switch back to auto. 			
2.2 <u>Topping up of wet stamp pressure system</u>			
Instructions for topping up of the wet stamp pressure system are found on the board against the oil tank. It is important that the pressure is watched carefully and topped up correctly when needed.			
2.3 <u>Shutdown</u>			
The shutdown procedure is the reverse of the startup. It is important to shut down the wet stamp pressure system as indicated in the instructions against the oil tank.			
3. <u>Changing Production</u>			
3.1 Run out the mix in the stirrer, wash the felt and stop the machine.			
3.2 Using the overhead crane, remove the production roller and replace with the new size roller.			
3.3 Using the overhead crane, remove the cutting frame and replace with the new frame.			
3.4 Set the cutting depth of the cutting frame.			
3.5 Change the size of the flat sheet and corrugated lifters and folder suction areas.			
3.6 Start the machine, start the offtake and produce a sheet. Check whether all lifters are working properly and check the up and down turns of the sheet. Adjust the mix stack trolley or corrugator as needed.			
3.7 Continue production.			
4. <u>Safety</u>			
4.1 Do not allow any person in the offtake area while the offtake is in operation.			
4.2 Always replace the guards on the wet stamp after changing the cutting frame and before starting the offtake.			
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S-28 SHEET PRODUCTION			SABS 0157 REF. 4.B.1		SECTION F.2.B.6	

4.3 Clean up all spillages immediately.

4.4 Do not stack more than the allowable number of sheets and form-plates on a carrier as this will prevent the crane from lifting it.

5. Quality

5.1 The Cutter, Offtake Operator and Offtake Assistant are to check all sheets for waste lumps, first layers or sieve marks.


5.2 Check the profile and up and down turn of the first sheet produced on a new carrier and adjust immediately if necessary. The profile gauge has clear indications of nominal, maximum and minimum allowable dimensions.

5.3 Do not produce sheets unless the SABS stamp and the inkjet printer are working.

6. Product marking

6.1 The SABS mark and batch identification details are embossed on the sheets as the sheets come off the production roller.

6.2 The coding is as follows:




EVERITE	B	---	---	---	---
COMPANY	SABS EMBLEM	FACTORY	YEAR	WEEK NO.	BATCH NO. SHIFT

6.4 The coding must be legible. Dies must be cleaned daily and replaced when worn.

6.5 In addition the following is printed on each sheet using the inkjet printer:

- i) Asbestos logo
- ii) Asbestos warning
- iii) Date
- iv) Shift

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MOULDED GOODS WET SHEET	SABS 0157	SECTION	
PRODUCTION	REF. 4.B.1	F.2.B.7	

FUNCTION: To ensure that good quality sheets are produced timeously against a Moulded Goods plan.

USERS: Shift Foreman, Shift Supervisor, Mixer

ACCOUNTABILITY: Shift Foreman

CONTENTS:

1. Production procedure.
2. Quality.
3. Safety.

1. Production Procedure


The following procedure assumes that the machine is running as per instruction F.2.B.6.

- 1.1 - The 3,6 m roller must be used.
 - The vat levels should be at ± 30 per vat.
 - Density should be 60.
 - Roller speed 65 m/min.
 - Roller pressure 2,5 bars.
- 1.2 The Moulded Goods plan requires specific sizes and quantities for various cost centres at specific times.
 - Sheet thickness is measured with the thickness gauge.
 - Only one cost centre's sheets per trolley.
 - Cost centre and size of sheet are written at the back of two of the sheets on the trolley.
 - When a size or cost centre is complete it is ticked off on the plan.
- 1.3 When the sheet is cut from the production roller, it is stopped on conveyor No 1 by a limit switch.

The moulded goods rollers roll the sheet onto the roller, transfer it down the ramp to the trolley and stack on the trolley as per instruction from the Cutter.

2. Quality

- 2.1 The Cutter conducts a visual and "feel" test of the sheet - pulling his finger across the sheet and checking for mouldability.
- 2.2 The Supervisor and Foreman use the quality bars at the side of the machine - testing the various sizes over the appropriate bars.
- 2.3 The Foreman liaises with the Supervisor of Moulded Goods by going into the department and checking the quality with them.

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3. Safety

The moulded goods trolley at the side of the machine must be parked with the steering wheel handle going backward, otherwise when stacked, it will topple over.

Gloves must be worn by all Moulded Goods Rollers.

Care must be exercised when lifting rollers as they are heavy and can cause back strain.

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S 28 UNPACKING OF MATURED SHEETS		SAHS 0157 REF. 4.8.1	SECTION F.2.8.8
<u>FUNCTION:</u>	To ensure that corrugated sheets are unpacked correctly so that optimum efficiency and quality is obtained.		
<u>USERS:</u>	Shift Foreman, Unpacker Operator, Unpacker Assistants		
<u>ACCOUNT- ABILITY:</u>	Shift Foreman		
<u>CONTENTS:</u>	1. Operating procedure. 2. Quality. 3. Safety and housekeeping.		
1. <u>Operating Procedure</u>			
1.1 Unpacking of sheets may only commence once the Shift Foreman is satisfied that the sheets have matured sufficiently to prevent sagging after unpacking.			
1.2 <u>Startup</u>			
<ul style="list-style-type: none"> - Check the level of the formplate oil in the sump. - Open the air valve against the pillar. - Open the gland water feed valve on the vacuum pump water tank. (green) - Open both the hydraulic oil valves underneath the buffer tanks. (dark blue) - Start all the pumps on the panel. - Set all product selector switches to No 1 for Bigsix sheets or No 2 for Canadian Pattern. - Set the mode switch to auto. - Set mix stack and formplate carriers in position and start the unpacker. 			
1.3 The Unpacker Operator should constantly adjust the height of the mix stack and sheet stack to keep the unpacker speed as high as possible.			
1.4 All sheets must be inspected as described in Section 2. Rejects are placed on a separate pallet.			
1.5 The number of sheets to be loaded on a pallet are displayed at the unpacker.			
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S 28 UNPACKING OF MATURED SHEETS

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REF. 4.8.1

SECTION
F.2.8.8

2. Quality

- 2.1 All sheets have to be inspected for profile, up turn and down turn. Inspect the first sheet offloaded onto the pallet and then every sheet which seems to differ from the bottom sheet.
- 2.2 Rejected sheets are packed on a separate pallet. A QC Inspector will then re-inspect these sheets and sort them into recoverables and not recoverables.
- 2.3 Sheets should also be inspected for thickness and surface imperfections such as waste lumps or first layers.
- 2.4 All the shavings must be brushed off at the unpacker.
- 2.5 Sheets must be dipped before being taken to the handover area.
- 2.6 Make sure that both sides of the formplate is oiled. Un-oiled formplates will rust and produce poor quality sheets.

3. Safety

- 3.1 Never allow anybody to move into the unpacker area while the machine is working.
- 3.2 Stand well clear when mix stack and sheet trolleys are moved.
- 3.3 Do not attempt to move formplates with your bare hands, always wear gloves.
- 3.4 Wear skid resistant safety boots.
- 3.5 Clean up all spillages and keep the unpacker floor area clean.

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OVERHEAD CRANES S 28	SAHS 0157 REF. 4.14.2	SECTION F.2.8.9	

FUNCTION: To ensure that carrier loads are transferred safely and efficiently without adverse effect on the quality of the sheets.

USERS: Shift Foreman S 28, Shift Supervisor S 28, Crane Drivers,

ACCOUNT-ABILITY: Shift Foreman

1. Description

Mix carriers are slung by the Offtake Assistant and with the aid of correct crane signals, are transferred to the stockyard for curing. The unpacker must be loaded at all times to supply the machine with oiled templates.

2. Method

It is important that the Crane Driver tests and inspects his crane at the start of the shift.


2.1 Inspection of crane before operating

- Ask the Crane Driver going off shift whether he has anything to report about the crane.
- Visually inspect the crane for any defects.
- Inspect all lifting equipment, ie: chains, slings, hooks and lifting booms.
- Carefully examine lifting cable for wear, broken wires and damage.
- Make sure that the hook and lifting boom are clear of all obstructions.
- Verify position of other cranes to avoid collision.
- Make sure that no-one else is on the crane.
- Make sure that there is no "DO NOT START" board on the main switch.

2.2 Operate the crane to test

- When entering the crane, only use the ladder provided.
- Enter cab and close safety gate.

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- c. See that all controls and main switch are in OFF position.
- d. Place main switch in ON position.
- e. Test to see if hooter/bell is working.
- f. Operate the hoist control to the UP position to lift hook and slings clear of obstacles. Only if hook and slings are not clear.
- g. Test cross travel control and brake.
- h. Inspect hoist cable by running out until hook is on floor. Look for broken wires, loose strands or kinks in the cable. When the cable is rewound on the drum, see that it is properly seated in the drum grooves.
- i. Test the overhoisting limit switch by inching the bottom hook up to the highest position while carefully watching it. The limit switch and brake should stop the motion at once. If the hoist brake is not correctly set or worn, the hook will drift too close to the cable drum and cause damage.
- j. Operate emergency switch to test if it disconnects all the power.
- k. Report all defects immediately to the Foreman.
- l. When leaving the crane, always switch off the main switch.

2.3 Hooking and lifting procedure

The following are habits and rules that you must use:-

- a. Always test your crane when you start a shift and report all defects.
- b. Crane controls must be operated smoothly and gradually to avoid abrupt and jerky movements to the load. Slack must be taken from the sling and hoisting cable before the load is lifted.
- c. Do not try to lift more than the rated load capacity of the crane, lifting boom, hook or slings.
- d. Do not allow the bottom block and the load to swing excessively. The load cable may jump out of the grooves or rub against the steelwork.

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	<ol style="list-style-type: none"> e. When picking up a load, bring crane hook vertically in line with the load. Cranes must not be used for side pulls. f. The crane must be centered over the load before starting the hoist to avoid swinging the load as the lift is started. g. Loads should not be swung by the crane to reach areas not under the crane. h. Before moving a load, hooks and sling must be placed firmly and correctly in the correct place. i. The load should be checked to be certain that it is lifted high enough to clear all obstructions and personnel when moving the load. j. Do not move a load over personnel on the floor without warning them beforehand. k. Insist on receiving clear and standard signals from the slingers before operating the crane. (See Annexure 1 for Crane Driver signals) l. When a very heavy load is lifted, the hoist brakes should be tested. Lift the load a few centimeters from the ground, return the switch to OFF position. If the hoist brakes do not hold, set load on floor and report. Do not operate. m. At no time should a load be held suspended from the crane unless the Crane Driver is at the controls. The load should be kept as close as possible to the floor to minimise the possibility of an accident if the load should drop. n. Do not use the upper limit switch every time when hoisting. It is a safety device and is not to be used as a production operating control. o. A crane should never move or bump another crane. p. The controls must always be stopped momentarily in the OFF position before reversing - except to avoid an accident. A slight pause is necessary to give the braking mechanism time to operate. q. When crane motors stop through tripping, investigate and find cause first before attempting to reset and start again. r. When lifting a load, make sure that it is balanced. 	
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OVERHEAD CRANES S 28

SABS 0157
REF. 4.14.2SECTION
F.2.8.9**2.4 Unloading procedure**

- a. Approach must be slow and steady to avoid swinging.
- b. When unloading, the load must be steady and straight.
- c. Slinger must straighten load.
- d. Carriers must not be stacked higher than three times its base width.

2.5 Loading and unloading of unpacker and production machines

- a. Ensure that the prime production machines have the required number of formplates.
- b. Unpacker must at all times be fully loaded, as prime production depends on the unpacker's capacity to offload formplates.
- c. Unpacked sheets must be dipped in water before being transferred to the handover bay.
- d. Only properly oiled formplates are to be transferred to the prime production machines.

2.6 At the end of shift the following must be done:-

- a. Raised all hooks to an intermediate position.
- b. Stop the crane at approved designated location only.
- c. Place all controls in OFF position.
- d. Place main switch in OFF position.
- e. Clean out crane cab.
- f. Make visual check before leaving the crane.

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	OVERHEAD CRANES - S 28			

ANNEXURE 1 (CRANE DRIVER SIGNALS)

<p>STOP</p>  <p>YIHA</p>	<p>MOVE AWAY FROM ME</p>  <p>BHEKELISA UNTHIHALO KUN</p>	<p>MOVE LEFT</p>  <p>YISA UNTHIHALO EKHOILO</p>
<p>MOVE THE LOAD TO ME</p>  <p>SONDESA UNTHIHALO KUN</p>	<p>STOP SLOWLY</p>  <p>YIHA KANCINANE</p>	<p>LOWER THE LOAD SLOWLY</p>  <p>THODA UNTHIHALO KANCINANE</p>
	<p>RAISE THE LOAD SLOWLY</p>  <p>NYUSA UNTHIHALO KANCINANE</p>	<p>RAISE THE LOAD</p>  <p>NYUSA UNTHIHALO</p>
<p>LOWER THE LOAD</p>  <p>THODA UNTHIHALO</p>	<p>EMERGENCY STOP</p>  <p>INGOZI YIHA</p>	<p>MOVE THE LOAD RIGHT</p>  <p>YISA UNTHIHALO EKUNENE</p>

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	SAHS 0157	SECTION
	REF. 4.40	F.2.8.10
CALIBRATION OF EQUIPMENT S 28		
<u>FUNCTION:</u>	To ensure that all measuring equipment at S 28 machine is calibrated on a regular basis by a competent person and so ensuring the quality of the finished sheet.	
<u>USERS:</u>	Shift Foreman S 28, Maintenance Manager	
<u>ACCOUNT-</u>		
<u>ABILITY:</u>	Shift Foreman S 28	
1. <u>Description</u>		
All of the items listed below are to be calibrated on a regular basis by the indicated person. The procedure to follow when calibrating the equipment is described in the person's job description, SPI or special instruction. Calibration periods will also be indicated in these documents.		
2.	ITEM	CALIBRA- TED BY
	CEMENT WEIGH BIN	BEM
	SILICA WEIGH BIN	BEM
	WATER WEIGH TANK	BEC
	FIBERISER	BEC
	PRODUCTION ROLLER PRESSURE GAUGES	BEM
	HRB MIXER	BEC
	DENSITY CONTROL	BEC
	HAND HELD THICKNESS GAUGES	BQ
	TAPE MEASURE	BQ
	PROFILE GAUGES	BQ
	SLURRY PUMP TIMER	SHIFT FOREMAN
3. <u>Control</u>		
a.	Calibrations done by BEM and BEC will be controlled by the Maintenance Planning Office (MPO). MPO will issue jobcards to the relevant sections when a particular piece of equipment is due for calibration.	
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	PROCESS CONTROL STANDARDS S 28			

EVERITE LTD *****	BRACKENFELL SHEET PLANT *****	PROCESS CONTROL TARGETS *****	MACHINE : S28 *****
Date			
Time			
Mix number			
Rollered fibre % water	30 +/- 1	30 +/- 1	
Product	Big six	Moulded	
Size	4 C/patt.	Goods	
Turns per sheet	7		
Layer thickness (mm)	0,90 +/- 0,6	0,90 +/- 0,6	
Plasticity radius (mm)	30 - 35	40 +/- 5	
Sheet thickness (mm)			
D/S	6,3	As	
C	+/-	Ordered	
N/D/S	0,2	by M/good	
Wet density			
D/S	1,83	1,83	
C	+/-	+/-	
N/D/S	0,85	0,85	
Sheet water content (%)			
D/S	28 +/- 2	30 +/- 2	
C	28 +/- 2	30 +/- 2	
N/D/S	28 +/- 2	30 +/- 2	
Offtake inspection			
Length	1		
Surface marks	1		
Forming fissures	1		
Upturn	1		
Downturn	1		
SABS, date and shift stamp	1		
General appearance	1		
Process controller			
Foreman			
Comments			
1 SEE SABS 0157 MANUAL			

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